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INVENTORY OF PRESENT WATER QUALITY IN THE BRAZOS, COLORADO, GUADALUPE, NECHES, NUECES, SAN ANTONIO, SAN JACINTO, AND TRINITY RIVER BASINS

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INVENTORY OF PRESENT WATER QUALITY

IN THE

BRAZOS, COLORADO, GUADALUPE, NECHES, NUECES, SAN ANTONIO, SAN JACINTO, AND TRINITY RIVER BASINS

Prepared in compliance with

WORK ASSIGNMENT 4.1

for the

U. S. STUDY COMMISSION - TEXAS

by the

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

JULY 1961

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TABLE OF CONTENTS

Page

LIST OF TABLES.............................. ii

LIST OF FIGURES............................. v

SYNOPSIS.................................... 1

INTRODUCTION................................ 7

PRESENT QUALITY OF WATER RESOURCES IN MAJOR BASINS

Brazos River Basin.................. 17

Colorado River Basin................ 81

Guadalupe River Basin............... 143

Neches River Basin.................. 165

Nueces River Basin.................. 193

San Antonio River Basin............. 219

San Jacinto River Basin............. 235

Trinity River Basin................. 251

WATER QUALITY CRITERIA...................... 301

IMPROVEMENT OF WATER QUALITY

Introduction........................ 303

Water Quality Degradation........... 303

Improvement of Water Quality at Source of Degradation...................... 305

Improvement of Water Quality in the Stream.............................. 314

Improvement of Water Quality Prior to Use................................. 316

REFERENCES.................................. 319

LIST OF TABLES

Page

1. Quantity and Quality of Basin Runoff to the Gulf of Mexico...................... 2

Brazos River Basin

B-1 Subarea Locations on the Main Stem......... 19

B-2 Discharge and Quality Stations with Period of Record................................. 39

B-2a Location of Texas Department of Health Quality Monitoring Stations................ 48

B-3 Municipal Water Supply and Waste Disposal.. 50

B-4 Saline Ground Waters....................... 73

Colorado River Basin

C-1 Subarea Locations on the Main Stem......... 82

C-2 Discharge and Quality Stations with Period of Record................................. 96

C-2a Location of Texas Department of Health Quality Monitoring Stations................ 105

C-3 Municipal Water Supply and Waste Disposal.. 107

C-4 Saline Ground Waters....................... 133

Guadalupe River Basin

G-1 Subarea Locations on the Main Stem......... 144

G-2 Discharge and Quality Stations with Period of Record................................. 155

G-2a Location of Texas Department of Health Quality Monitoring Stations................ 158

G-3 Municipal Water Supply and Waste Disposal.. 160

G-4 Saline Ground Waters....................... 163

LIST OF TABLES (Continued)

Page

Neches River Basin

Ne-1 Subarea Locations on the Main Stem.............. 166

Ne-2 Discharge and Quality Stations with Period of Record.. 174

Ne-2a Location of Texas Department of Health Quality Monitoring Stations..................... 177

Ne-3 Municipal Water Supply and Waste Disposal....... 178

Ne-4 Saline Ground Waters........................... 190

Nueces River Basin

Nu-1 Subarea Locations on the Main Stem.............. 194

Nu-2 Discharge and Quality Stations with Period of Record.. 202

Nu-2a Location of Texas Department of Health Quality Monitoring Stations..................... 206

Nu-3 Municipal Water Supply and Waste Disposal....... 207

Nu-4 Saline Ground Waters........................... 212

San Antonio River Basin

SA-1 Subarea Locations on the Main Stem.............. 220

SA-2 Discharge and Quality Stations with Period of Record.. 226

SA-2a Location of Texas Department of Health Quality Monitoring Stations..................... 229

SA-3 Municipal Water Supply and Waste Disposal....... 230

SA-4 Saline Ground Waters........................... 233

LIST OF TABLES (Continued)

Page

San Jacinto River Basin

SJ-1 Subarea Locations on the Main Stem......... 236

SJ-2 Discharge and Quality Stations with Period of Record......................... 242

SJ-2a Location of Texas Department of Health Quality Monitoring Stations................ 244

SJ-3 Municipal Water Supply and Waste Disposal.. 245

SJ-4 Saline Ground Waters...................... 249

Trinity River Basin

T-1 Subarea Locations on the Main Stem......... 253

T-2 Discharge and Quality Stations with Period of Record......................... 270

T-2a Location of Texas Department of Health Quality Monitoring Stations................ 277

T-3 Municipal Water Supply and Waste Disposal.. 279

T-4 Saline Ground Waters...................... 297

Improvement of Water Quality

I-1 Average Composition of Domestic Sewage..... 304

I-2 Characteristics of Certain Industrial Wastes................................... 306

I-3 Unused and Used Water Supplies............. 312

LIST OF FIGURES

Following Page

B-1 Brazos River Basin - Discharge & Quality Sampling Stations........................... 80

C-1 Colorado River Basin - Discharge & Quality Sampling Stations........................... 142

G-1 Guadalupe River Basin - Discharge & Quality Sampling Stations........................... 164

Ne-1 Neches River Basin - Discharge & Quality Sampling Stations........................... 192

Nu-1 Nueces River Basin - Discharge & Quality Sampling Stations........................... 218

SA-1 San Antonio River Basin - Discharge & Quality Sampling Stations........................... 234

SJ-1 San Jacinto River Basin - Discharge & Quality Sampling Stations........................... 250

T-1 Trinity River Basin - Discharge & Quality Sampling Stations........................... 300

I-1 Quality Degradation in the Hydrologic Cycle...................................... 318

I-2 Methods of Quality Improvement for Water Conservation.............................. 318

SYNOPSIS

This report describes the existing quality of water resources in the U. S. Study Commission - Texas area and is intended to serve as a basis for estimating future quality as the regimen of the rivers and the waste loadings thereto are changed.

Data on the quality of water resources in Texas are available from three sources: the Texas State Department of Health, the Texas Board of Water Engineers, and the Geological Survey of the U. S. Department of the Interior. It should be noted here that these agencies have much more information, both published and in their files, than could be considered in this over-all evaluation.

Although records of 295 active and inactive discharge gages are published, similar continuous chemical quality measurement by the Geological Survey is available for only 48 stations; consequently, much of the quality evaluation was based on data from the Texas Department of Health's quality monitoring network, which has been in operation only since September, 1957. Since the latest published discharge data are for water year 1957-58, "present" water quality in this report applies to that year.

The criteria upon which the quality of water resources was evaluated in this report were those adopted by the Commission in May, 1960. At most stations, the concentration of total dissolved solids was considered the primary indicator of quality; other constituents were assumed to be proportional to this analysis. This assumption is admittedly an oversimplification, since organic pollution is of primary significance in evaluating the sanitary quality of a water source. However, organic materials, being relatively unstable, are subject to varying degrees of self-purification, and their inclusion would require either intensive field investigation or a complex series of computations leading to an estimated reach of river affected by oxygen depletion. Moreover, organic pollution is amenable to conventional biological waste treatment, and the progressive policy of the Texas Department of Health promises satisfactory reduction of these pollutants; a current example of this policy is the intensive organic pollution survey of the Dallas-Fort Worth complex on the upper Trinity River and its tributaries. Implementation and enforcement of the recommendations in the report of that survey may well result in a precedent-setting reduction in "dilution water" requirements for sewage treatment plant effluents.

In general, the existing quality of the surface water resources in the USSC-T area ranges from good to excellent, except for natural and oil-field sources of chloride and gypsum in the headwaters of the Brazos and similar pollution in the headwaters of the Colorado. The man-made pollution problems are amenable to solution through stringently enforced waste treatment requirements. Table 1 shows the quantity and quality of water at the mouths of each of the eight basins under study.

TABLE 1

QUANTITY AND QUALITY OF BASIN RUNOFF TO THE GULF OF MEXICO

(As measured at stations nearest the Gulf)

Basin (1)	Drainage Area Contributing (sq. mi.) (2)	Runoff (cfs) 1940-56 (3)	Runoff (cfs) 1957-58 (4)	Hardness ppm (5)	Dissolved Solids ppm (6)	Dissolved Solids Tons/ day (7)
Brazos (mile 93)	35,400	7,280	11,870	166	303	9,710
Colorado (mile 67)	29,863	2,410	6,128	147	211	3,490
Guadalupe (mile 51)	6,033	1,330	3,541	177	264	2,520
Neches (mile 55)	9,995	8,100	8,465	27	83	1,900
Nueces (mile 48)	16,954	656	1,538	115	233	968
San Antonio (mile 67)	4,217	552	974	188*	332*	875*
San Jacinto (mile 38)	3,932	2,660	1,372**	41**	102**	378**
Trinity (mile 94)	17,845	8,010	11,690	113	215	6,790

*From Latest U. S. Geological Survey quality data (1945-46) corresponding to 971 cfs.

**From latest U. S. Geological Survey quality and discharge data (1952-53). Lake Houston now covers this site.

The remainder of the synopsis consists of individual summaries of the detailed basin studies, arrayed alphabetically.

Brazos River Basin

The Brazos River is unique in comparison with other rivers. Whereas most rivers are purest in the headwaters, becoming progressively polluted as they flow toward the sea, the Brazos River is at its worst in the headwaters due to natural salt and gypsum deposits, and oil field brines, and it improves in quality only as it is diluted with good quality tributary waters. Its best recorded chemical quality occurs over 800 miles downstream from its origin, 93 miles upstream from the Gulf of Mexico.

The main stem of the Brazos River begins at river mile 899, at the confluence of Double Mountain Fork and Salt Fork.

Water in Double Mountain Fork is characteristically higher in sulfate than chloride - the weighted average in 1957-58 being 592 ppm and 265 ppm respectively. The high sulfate content originates in the natural deposits of gypsum in the subbasin. Existing Geological Survey chemical quality and discharge data at river mile DM-35 show the following conditions near the mouth of Double Mountain Fork. Total dissolved solids range from 636 ppm to 6,350 ppm. The weighted average for water year 1957-58 was 1,390 ppm, or 488 tons per day. Although somewhat suitable for use in irrigation, such use would be expected to increase the already overloaded concentration of solids.

The Salt Fork is characteristically higher in chloride than sulfate, the weighted averages in 1957-58 being 4,410 ppm and 826 ppm respectively. This water is not even suitable for irrigation because of its excessive chloride content. Based on Geological Survey quality and discharge data at mile SF-29, total dissolved solids range from 1,280 to 78,500 ppm. The weighted average for water year 1957-58 was 8,500 ppm; in the average flow of 71 cfs for that year, this would amount to 1,640 tons per day. Studies are being sponsored by the Texas Board of Water Engineers, the Brazos River Authority and the U. S. Geological Survey to determine the specific sources of salt in the area and possible means of keeping the salt out of the Brazos River.

The Brazos River Authority has stated, "The run-off from this portion of the basin in its undiluted condition is largely unsatisfactory for municipal and industrial uses and also for irrigation, except on lands with soil characteristics favorable to applications of excessive amounts of water for leaching. Unless and until practical means of controlling salt intrusions are devised, water for municipal use in the watershed of the main Brazos River above the mouth of the Clear Fork will be essentially limited to that obtainable from certain small tributary watersheds." III-8/

Colorado River Basin

Brine from natural sources and from oil field operations is the plague of the Colorado River headwaters.

Local pollution in the Beals Creek watershed is caused by natural salt springs. A single sample collected in August, 1958 had 1,800 ppm dissolved solids, 640 ppm chloride, and 356 ppm sulfate.

The major area of natural salt pollution on the Colorado River lies below Lake J. B. Thomas and above Colorado City. The effect on the river's quality is apparent from the increase in dissolved solids: Lake J. B. Thomas (mile 845), 270 ppm; Colorado City (mile 796), 1,880 ppm.

At mile 659, the Colorado River had an average flow of 248 cfs during water year 1957-58; the quality at this point reflects upstream diversions for irrigation, municipal supplies, salt springs, and oil field operations. Dissolved solids ranged from 1,056 to 2,730 ppm; chlorides from 296 to 1,000 ppm; and sulfates from 170 to 575 ppm.

The water quality improves progressively from mile 474 to the mouth. At mile 67, the mean flow (6,128 cfs) contained only 211 ppm dissolved solids.

Guadalupe River Basin

In general, the water of the Guadalupe River Basin is of excellent quality. The one exception is Plum Creek, which is described below.

At mile 397 (the farthest upstream gaging station), the mean flow during water year 1957-58 had only 204 to 375 ppm total solids.

The San Marcos River joins the Guadalupe at mile 176; Plum Creek discharges about 143 cfs to the San Marcos at mile 19. The poor quality water in Plum Creek (1,117 ppm total solids and 420 ppm chlorides) is apparently due to brine-producing oil field activity above this station.

The flow in San Marcos River (762 cfs) dilutes the discharge from Plum Creek to acceptable quality (400 ppm total solids) before joining the Guadalupe.

Quality and discharge records for the Guadalupe River at Victoria (mile 51) indicate 3,541 cfs containing only 264 ppm dissolved solids.

The San Antonio River discharges about 974 cfs to the Guadalupe at mile 11. Three miles downstream, at mile 8, about 4,700 cfs containing from 153 to 585 ppm total solids flowed to San Antonio Bay and thence to the Gulf.

Neches River Basin

The waters of the Neches are of generally good quality except for some organic pollution in the headwaters, and in the lower reach of the Angelina.

At mile 333, the farthest upstream gaging station, the average flow of 1,103 cfs contained total solids ranging from 81 to 357 ppm.

The Neches River shows progressive improvement in quality to the farthest downstream discharge-quality station at mile 55, where 8,465 cfs containing only 83 ppm dissolved solids passes on its way to the Gulf.

Nueces River Basin

Except for the water in two intermittent tributaries, the Frio and the Atascosa, the Nueces may be rated as of generally good quality.

The farthest upstream discharge-quality station is at mile 395, where the mean flow, 308 cfs, contained 217 to 342 ppm total solids.

The Frio River joins the Nueces at mile 104, and the Atascosa joins the Frio at mile 13. The Frio contributed 615 cfs during 1957-58 containing total solids ranging from 147 to 1,008 ppm. The Atascosa contributed about 265 cfs containing total solids ranging from 153 to 1,330 ppm. Average flow for a 27 year period was 257 cfs in the Frio, and 139 cfs in the Atascosa.

Dilution and impoundment improve the quality of the Nueces until, at mile 48, the mean flow of 1,538 cfs contains only 233 ppm dissolved solids.

San Antonio River Basin

The Medina River joins the San Antonio River at mile 210. In 1957-58, during periods of high water, the city of San Antonio discharged about 14,060 acre-feet of sewage effluent from Mitchell Lake to the Medina River. A considerable part of the low flow in the Medina River is sewage effluent from Kelly Air Force Base which enters by way of Leon Creek. Mean discharge from Medina River during water year 1957-58 was 203 cfs, with dissolved solids ranging from 321 to 690 ppm and BOD from 0.5 to 10.2.

The city of San Antonio discharged an average 77 cfs to the San Antonio River about 8 miles below the city.

At mile 151, the San Antonio River contained total solids ranging from 186 to 810 ppm; the BOD had diminished to 0.5 - 3.3 ppm.

Fifteen miles upstream from its point of discharge to the Guadalupe River, the San Antonio River had a mean flow of 974 cfs containing total solids ranging from 339 to 900 ppm.

San Jacinto River Basin

The San Jacinto River is formed at the junction of its East and West Forks, about 38 miles above its mouth. Lake Houston is formed by a dam at mile 35. The quality of water in this impoundment is expected to be good, with only 165 ppm dissolved solids and 56 ppm hardness. The flow at the dam site during 1936-53 was 1,958 cfs.

Unless kept under close control, oil field brines may be a source of quality degradation; especially in Lake Houston, where evaporation has already been reported to increase salt concentrations during periods of low runoff.

Trinity River Basin

Water quality in the upper Trinity is vividly described in the report "Upper Trinity Sewage and Industrial Waste Survey" of the Texas State Department of Health, dated July, 1960: "At the confluence of Marine Creek, beginning with the West Fork Trinity River in Fort Worth, and extending downstream to a point near Rosser in Kaufman County, the Trinity River is devoid of oxygen and is unable to accomplish self-stabilization. Oxidation of organic matter is retarded and septic conditions and offensive odors are usually present. The water is turbid and discolored. Sludge banks may be observed at numerous locations. There is insufficient oxygen for fish to propagate."

Passing through the Fort Worth-Dallas metropolitan complex, the dissolved solid content of the Trinity River increases from 229 ppm to 1,238 ppm, but is diluted to 524 ppm by the time it leaves the complex (at mile 451). After leaving the complex, a steady improvement in quality takes place until, at mile 94, the mean discharge for water year 1957-58 of 11,690 cfs contained only 215 ppm dissolved solids and 113 ppm hardness.

INTRODUCTION

Authority

This report has been prepared in compliance with Work Assignment 4.1, plan items B1a2 and B1b2: "Inventory of Present Water Quality and Compilation of Criteria."

Purpose

Knowledge of past and existing quality of water resources is essential to planning for their future use. If the waters are of good quality, planning for future use should include considerations for maintaining a re-usable quality through multiple use. If the waters are of poor quality, due to either man-made or natural pollution, consideration should be given to improving the quality for optimum utilization. The purpose of this report is to summarize the pertinent water quality information that is available, discuss the present quality conditions, and thus present a basis for estimating future water quality as the regimen and waste loadings are changed.

Character and Scope

The character and scope of this report have been specified in Work Assignment 4.1: "(1) Summarize, analyze, and report on available data on existing sanitary and chemical quality of ground water, non-tidal surface water, and tidal water within the U. S. Study Commission - Texas area. (2) Compile and report on water quality criteria for consideration by the Commission. (3) Report and discuss the means and physical benefits that may be anticipated from measures for the improvement of water quality."

Item (2) was adopted by the Commission on May 2, 1960, and is included in this report on page 301.

Need for Evaluation of Water Quality

Any one who has ever stood on the banks of a river, the shores of a lake, or ridden in a boat has automatically and unconsciously evaluated the quality of that water. His first observation would be the appearance of the water, as to whether it was turbid or clear; second, whether it had a color; third, if it were a grossly polluted water -- the odor would be commented on. Another common evaluation made by persons dipping their hand or foot into the water is that of temperature. Except for the sports enthusiasts who might use this general evaluation to decide whether or not to swim or water ski in the water, the casual observer might do no more than comment that it's a "beautiful" stream or lake, or that it is "foul."

An engineer looking at that same body of water or stream might make these same observations; but if he were considering the water for a municipal, industrial, or agricultural use, he would have to describe it not only in terms of what he saw (in numerical terms of intensity) but also its physical, chemical, bacteriological, and biological quality in numerical terms, for quality is only significant when it affects its potential users' requirements.

Preliminary Data Needed for Evaluation

The existing quality of surface waters at a proposed water plant intake or quality sampling station is the product of the complex of contacts that the water has made prior to reaching this point. Thus, before attempting to interpret the results of quality-related laboratory analyses, a survey of the watershed upstream from the point of sample collection should be made to indentify pertinent quality-affecting features.

There are more than fifty laboratory analyses that have quality significance to various users. The cost and time that would be required to perform all of these analyses would be prohibitive for normal evaluation. Fortunately, a few relatively simple analyses are indicators of quality that are not only useful in themselves, but reveal the nature of the source of pollutants and thus the need, or lack of need, for certain other analyses. Indicator analyses include total solids, dissolved solids, color, pH (a measure of the point on the acid-neutral base scale), biochemical oxygen demand (the dissolved oxygen content and the rate at which oxygen is depleted by biological and chemical forces), coliform bacteria, plankton (the number and type of living organisms in a unit volume of the water), and hardness (a measure of the soap consumption and boiler scale potential). A listing of the indicator analyses that are performed routinely on samples collected from selected stations in the waters of Texas is shown on page 11.

Quality Requirements for Municipal Use

The potential raw water supply for municipal use must be quality-evaluated to determine whether it meets specific limits on bacterial content, that it does not contain any toxic, taste producing, or otherwise harmful substances or organisms that are not readily and completely removable by ordinary water treatment. The raw water should be free of excessive amount of acids, minerals, microscopic organisms, and organic matters causing any interference with the normal operation and efficiency of water treatment processes.

Quality Requirements for Industrial Use

Industrial use of water is made in three distinct quality categories: (1) cooling water (which can often be satisfied by sea water); (2) general purpose water (water used for drinking, culinary use, laundries, and other personnel-related uses that require a water of quality similar to that described above for municipal use); and (3) boiler-feed water and process water -- analyses pertinent to a quality evaluation of waters to be used as boiler-feed water and nine classes of industry are shown here to indicate the significiance of specific analyses in the evaluation of the potential industrial water sources:

(a) Boiler-feed Water
The quality requirements of boiler-feed water become increasingly stringent for increasing design operating pressures. Specific limits are set for turbidity, color, oxygen consumed, dissolved oxygen, hydrogen sulfide, total hardness, aluminum oxide, silica, carbonate, hydroxide, total solids, and pH.

(b) Mining
Waters used for oil well flooding should be free from turbidity, iron, manganese, hydrogen sulfide, and low in calcium carbonate. The mechanical mining of coal requires a clear water that is not slime forming.

(c) Primary Metal Products
Process water to be used in the primary metals products industry (aluminum, iron, steel, magnesium, tin, and zinc) should meet specific numerical limits on temperature, chlorides, pH, hardness, suspended matter, organic content, and corrosion potential.

(d) Transportation Equipment
Electroplating process water makes the major demands in this industry. Water of zero hardness is required for all stages of electroplating; turbidity and iron are objectionable as are chlorides, sulfates, and free carbon dioxide.

(e) Stone, Clay, and Glass Products
Process water should be clear, low in color, free from iron, manganese, and organic growths, low in dissolved minerals, and of constant composition.

(f) Food and Kindred Products
A wide range of quality requirements exists in this industry. Since the end product is designed for human consumption, the process must have a minimum quality equal to that of drinking water. Thus, the process waters for food products in general should be clear, colorless, free from iron, manganese, objectionable tastes, and odors, and approved bacteriological quality. Requirements for specific food industries not only vary widely but are sometimes conflicting; for example, high sulfate hardness that makes water desirable for the fermentation industry makes it unusable for canning peas, beans, or lentils.

(g) Textile Mill Products
The wet processing of textiles requires water that is free from turbidity, color, iron, manganese, hardness, organic growths, and must be noncorrosive. Organic growths such as algae, crenothrix, molds, and slimes are very objectionable as they cause clogging, staining, odors, and wastage.

(h) Paper and Allied Products
Process water for this industry has definite tolerance limits involving turbidity, color, iron, manganese, free carbon dioxide, calcium hardness, and must be completely free from corrosive hydrogen sulfide, color, and odor.

(i) Chemical and Allied Products
(Principally petrochemical in the U. S. Study Commission - Texas area.) Most chemical manufacturing processes use large quantities of steam for heating, processing, generation of electricity, or directly for plant operations. The process water quality requirements vary widely within the industry. Besides being clear, colorless, and free from iron, manganese, hydrogen sulfide, and organic growths, additional limits depend on the chemicals being produced to the extreme requirement of distilled water for chemically pure chemicals, drugs, and pharmaceuticals.

(j) Petroleum and Coal Products
The process water is primarily for steam production and the quality requirements are as for boiler-feed water.

Quality Requirements for Agricultural Use

Quality requirements for waters to be used for irrigation differ from those of water to be used for domestic or industrial purposes. Whereas irrigation water should be relatively high in calcium and magnesium, which are the prime constituents of hardness, municipal and most industrial water users prefer a soft water. Boron has little significance in domestic supplies, but has critical low tolerance limits in waters to be used for irrigation. Fluorides, nitrates, and silica are not objectionable in irrigation water, but they are undesirable in municipal and most industrial waters.

Quality Requirements for Recreation Use

Waters to be acceptable for swimming and bathing should conform to three general conditions: (1) be esthetically enjoyable; that is, free from obnoxious floating or suspended substances, objectionable color and foul odors; (2) contain no substances that are toxic upon ingestion or irritating to the skin; and (3) be reasonably free from pathogenic organisms.

Sources of Water Quality Data in Texas

The U. S. Geological Survey performs and publishes the results of the following laboratory analyses: silica, iron, calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, chloride, fluoride, nitrate, boron, dissolved solids, hardness, per cent sodium, sodium absorption ratio, specific conductance, and pH. A total of 48 sampling stations are, or have been, analyzed for these constituents. The U. S. Geological Survey has also published discharge records for a total of 295 stations. The most recent publication of these discharge and quality data is for the water year 1957-58.

The Texas State Department of Health has operated a statewide water quality sampling program since September, 1957. The network of sampling stations, which have been sampled about twice a month since the program was inaugurated, includes 154 stations in the U. S. Study Commission - Texas area. Although these data have not been published, the Texas Department of Health furnished the Public Health Service with a "machine run" that included all analyses performed through August, 1960. The following data are listed for each station: pH, specific conductance, BOD, total solids (based on specific conductance), dissolved oxygen, chlorides, chlorine demand, and sulfates.

As noted above, the most recent discharge data are for water year 1957-58; the earliest statewide quality data are also for the water year 1957-58. Consequently, in order to utilize the maximum number of correlated quality-discharge data, water year 1957-58 was selected for evaluation.

The Texas Board of Water Engineers also indexes and publishes the water quality analyses and discharge records of the U. S. Geological Survey in addition to their own publications on the various aspects of surface and ground water resources in the State of Texas. Publications utilized in the preparation of this report are noted in the bibliography.

Significance of Analyses

Records of the following analyses, which were the basis of this quality evaluation, are listed alphabetically with a brief statement of their significance:

(1) Bicarbonates
Bicarbonates may reach water from many natural sources, including absorption of carbon dioxide from the air and the decomposition of organic matter; or they may be discharged by innumerable industrial processes, for bicarbonates are among the most commonly used salts. Other than the fact that excessive bicarbonates add to the salinity and total solids content of water, and tend to form carbonates and scale at high temperatures, bicarbonates in water are seldom considered to be detrimental.

(2) Biochemical Oxygen Demand

This test, abbreviated "BOD," does not reveal the concentration of any specific material. It is a measure of the rate of depletion of oxygen due to the metabolism of organisms living on putrescible organic matter in the water. This analysis has very little intrinsic value, since its significance is dependent on the reaeration properties of the stream.

(3) Boron

The significance of boron in drinking water has not been established. While traces of boron are necessary for good plant growth, concentrations above 2 to 5 ppm may be injurious to many plants.

(4) Calcium

Calcium salts are among the most commonly encountered substances in water. They may result from the leaching of soil and other natural sources, or they may be contained in sewage and in many types of industrial wastes. Their only significance in municipal supply is that they cause incrustations on cooking utensils and water heaters.

(5) Carbonate

The concentration of carbonates in natural or polluted waters is a function not only of the substances added thereto but also of complex interaction of other chemical constituents. They have no established significance in domestic water supplies; but excessive carbonates are known to interfer with carbonated beverages, brewing, ice making, and with boiler water.

(6) Chlorides

Chlorides are almost universally present in natural waters. Significant quantities of chlorides in water may originate from natural sources such as those found in Dove Creek in the headwaters of the Brazos River, from sea water intrusion, from salts spread on lands for agricultural purposes, from human or animal sewage, or from industrial effluents such as those from paper works, galvanizing plants, water softening plants, oil wells, and petroleum refineries. They are significant in domestic water supplies when they increase abruptly, which would be an indication of possible pollution of the water source, and when they exceed 250 ppm, a concentration that may cause taste. Industries with the lowest recommended threshold concentration of chlorides are sugar making (20 ppm) and ground wood and soda pulp paper making (75 ppm). Chlorides are a critical constituent of irrigation waters with certain crops being sensitive to concentrations as low as 70 ppm.

(7) Chlorine Demand

This is a measure of the relative amount of organic constituents subject to chemical reduction in the water. The Texas State Department of Health has established a quality limit of 6 ppm. Waters containing this amount or greater are considered of poor organic quality.

(8) Dissolved Solids

A wide range of recommended threshold concentrations are specified for the various uses. These limits are based primarily on the effects attributable only to total salt concentrations, or osmotic pressure, without reference to the effects of the salt constituents separately. Since these constituents include carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrates of calcium, magnesium, sodium, and potassium, with varying amounts of iron, manganese, and any other soluble materials, a high concentration of dissolved solids indicates a need for a quantitative listing of its potentially harmful constituents. Also, see (18), "Specific Conductance."

(9) Fluoride

In drinking water a concentration of fluoride exceeding 1.5 ppm tends to cause mottling of enamel of children's teeth. A concentration of 0.8 to 1.5 is recommended in drinking water by the Public Health Service for the prevention of dental caries.

(10) Hardness

The term hardness refers to the soap-neutralizing power of the water. Hardness is attributable principally to calcium and magnesium ions. Hardness over 100 ppm in domestic supplies causes a waste of soap and the incrustation of utensils. Excessive hardness in industrial water supplies is undesirable, especially in laundries, carbonated beverages, metal finishing, dying and textile industries, food processing, paper and pulp, bottle washing, photography, and leather goods.

(11) Iron

The significance of iron in municipal water supplies lies in its tendency, especially in combination with manganese, to stain laundry and porcelain fixtures in concentrations higher than 0.3 ppm. Concentrations in excess of 0.2 ppm can be expected to foster the growth of a slime organism, crenothrix bacteria.

(12) Magnesium

High concentrations of magnesium salts in drinking water have a laxative effect and thus a limit value of 125 ppm has been set in drinking water standards.

(13) Nitrate
Nitrate in water is often the final oxidation product of aerobic stabilization of organic matter and thus may indicate previous contamination by sewage. The quantities of nitrate present in surface waters usually amount to less than 5 ppm and have no affect on the value of the water for ordinary uses. A limit of 20 ppm has been placed on the nitrate concentration in the criteria adopted by the Commission, since concentrations in excess of this amount have a tendency to cause infant methemoglobinememia.

(14) Silica
Silica is dissolved from practically all rocks. A common range of concentration in natural waters is from 10 to 30 ppm. Silica is significant in water supplies since it contributes to the formation of boiler scale and forms deposits on the blades of steam turbines.

(15) Sodium
Moderate quantities of sodium (and potassium) have little effect on the usefulness of water for most purposes, but waters that contain more than 50 to 100 ppm of the two may require careful operation of steam boilers to prevent foaming. More highly mineralized waters that contain a large proportion of sodium salts may be unsatisfactory for irrigation. (See Per Cent Sodium (17), and Sodium Adsorption Ratio (16)).

(16) Sodium Adsorption Ratio
The sodium adsorption ratio is the relative proportion of sodium to other cations in an irrigation water. Values exceeding 26 indicate a very high sodium water which is generally unsatisfactory for irrigation.

(17) Sodium, Per Cent
This analysis is significant in irrigation waters, since a value of more than 60 may be injurious when applied to certain types of soils, particularly when adequate drainage is not provided.

(18) Specific Conductance
The specific conductance of a water is a measure of its capacity to conduct a current of electricity. The conductance varies with the concentration and degree of ionization of the different minerals in solution and with the temperature of the water. Thus it constitutes a fast method of determining the concentration of the total quantity of dissolved minerals in surface waters.

(19) Sulfate
Sulfate is dissolved from many rocks and soils, especially in gypsum and beds of shell. Since it is also formed by the oxidation of sulfides of iron, it is therefore present in considerable quantity in waters from mines. Sulfate in waters that contain much calcium and magnesium cause the formation of hard scale in steam boilers and may increase the cost of softening the water.

Format

Discussion of water quality data in each of the basins is arrayed in order from the headwaters to the mouth. Subareas in each basin are listed in order of their occurrence on the main stem. Each basin has a table describing the location of those subareas and their tributary-subtributary relationship.

Ground water quality is discussed concurrently with surface waters.

Reference tables of municipal water supplies and waste-water disposal, location of discharge gages and quality sampling stations with period of record, and saline water sources are included in each basin chapter.

Acknowledgments

This report was prepared from information published in the water supply papers of the U. S. Geological Survey; published and unpublished quality data furnished by the Texas State Department of Health; and the various indexes and pertinent publications of the Texas Board of Water Engineers.

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BRAZOS RIVER BASIN

Present Quality of Water Resources in the Brazos River Basin

Section, or Subarea	Page
Physical Description	17
1A	19
1B	20
2A	21
2B	22
2C	23
2D	24
2E	25
2F	26
3A	27
3B	28
3C	29
3D	30
3E	31
3F	32
3G	33
3H	35
4A	36
4B	37
Statement of Texas Department of Health	38

Physical Description

Geography

The Brazos River Basin covers a long, narrow area that roughly bisects the State of Texas in a northwest to southeast direction. The drainage area of about 44,670 square miles (42,000 in Texas and the remainder in New Mexico) is greater than the entire State of Tennessee or any of sixteen other states. It is bound by the Colorado River on the west, the Red River on the north, and the Trinity River on the east-northeast.

Topography

The Brazos River Basin may be divided topographically into three general areas: (1) the broad semi-arid plateau section at the New Mexico-Texas border, about 4,000 feet above sea level; (2) strongly rolling and deeply dissected plains country that extends from about 200 miles below the headwaters to the Balcones Fault Zone, about river mile 410; and (3) from the fault zone, where the elevation has dropped to about 400 feet, to the Gulf, the river flows through gently sloping prairies of a moist, subhumid zone.

Rainfall-Runoff

Average rainfall varies from 15 inches in the headwaters to 45 inches at the Gulf. Although the entire basin is subject to heavy rainstorms, severe weather in the headwaters consists of dust and sandstorms and may reach typical hurricane intensity in the Gulf area. About 9,240 square miles of arid lands in the upper area of the subbasin are considered noncontributing to the river flows.

The runoff at the furthest upstream station on the Brazos River, mile 832, consists of the combined flows from Double Mountain Fork and Salt Fork. During water year 1957-58, the average discharge from the two headwater tributaries was 130 cfs and 71 cfs respectively.

Runoff during water year 1957-58 at subsequent stations was: at river mile 832 - 296 cfs; river mile 758 - 816 cfs, of which about 314 cfs was contributed by Clear Fork; river mile 667 - 1,226 cfs, reflecting control at Possum Kingdom Reservoir twenty miles upstream; river mile 511 - 2,020 cfs; river mile 439 - 2,322 cfs, 3.4 miles below Whitney Dam; river mile 404 at Waco - 3,289 cfs; river mile 285 - 8,469 cfs, including runoff from Leon River and tributaries; river mile 196 - 10,910 cfs, including runoff from the Navasota River and Yegua Creek; river mile 93 - 11,870 cfs; river mile 67 - 11,630 cfs (decrease between river mile 93 and river mile 67 reflects extensive diversion for irrigation, industrial, and municipal supplies).

Impoundments

There are 23 major impoundments in the Brazos River Basin, as well as over 93,000 various diversion structures; the latter for irrigation, municipal, industrial, oil field operation, power, mining, and recreation use.

Present Quality of Surface and Ground Waters In Subareas of Brazos River Basin

The locations of all subareas of the Brazos River Basin are shown in Figure B-1 and Table B-1.

TABLE B-1

BRAZOS RIVER
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure B-1)

- 2E. Brazos River main stem from mile 899 to mile 756.
  - 2A. Salt Fork Brazos joins Brazos River at mile 899.
    - 1A. White River discharges to Salt Fork at mile 113.
  - 2B. Double Mountain Fork joins Brazos River at mile 899.
    - 1B. Upper half of Double Mountain Fork.
  - 2D. Clear Fork Brazos joins Brazos River at mile 759.6.
    - 2C. Upper half of Clear Fork Brazos.

- 2F. Brazos River main stem from mile 756 to mile 508.

- 3C. Brazos River main stem from mile 508 to mile 406.
  - 3B. Bosque River joins Brazos River at mile 406.5

- 3G. Brazos River main stem from mile 406 to mile 232.
  - 3D. Lampasas and Little Rivers. Little River joins Brazos at mile 310.
    - 3A. Leon River joins Lampasas to form Little River.
    - 3E. San Gabriel River joins Little River at mile 44.
  - 3F. Yegua Creek joins Brazos River at mile 254.
  - 3H. Navasota River joins Brazos River at mile 239.

- 4A. Brazos River main stem from mile 232 to mouth.

- 4B. Adjoining area to tidal waters.

Subarea 1A

Subarea 1A is the White River watershed which drains an area of 2,590 square miles. It discharges to the Salt Fork Brazos River at mile 113.

There are no quality sampling stations or discharge gages in Subarea 1A. A grab sample from mile 44 was collected by the U. S. Geological Survey on July 23, 1958. Analysis of this sample indicated a chemical quality that was within the limits of the adopted criteria: total dissolved solids, 419 ppm; chlorides, 29 ppm; sulfates, 58 ppm; and hardness, 200 ppm. At the time this sample was collected, the flow was only 0.30 cfs at mile 112.

A discharge gage was operated from 1939 to 1949 about 100 miles upstream from the mouth of White River. The average flow during the ten year period was 4.9 cfs, with a maximum of 12,000 cfs and a minimum of zero flow.

Ground waters in Subarea 1A are obtained chiefly from the Ogallala formation. Cities in this subarea that obtain their water from the Ogallala formation are Plainview, Crosbyton, and Ralls. During 1958, the city of Plainview used 3,310 acre-feet from wells that are about 300 feet deep. A sample collected in February, 1952, had the following quality analysis:

Analysis	Concentration (ppm)
Total Solids	440
pH	8.0
Alkalinity	285
Silica	57
Total Hardness	276
Calcium	48
Magnesium	38
Sodium	38
Iron	0.05
Sulfate	37
Chloride	25
Fluoride	2.8
Nitrate	1.8

Subarea 1B

Subarea 1B is the upper portion of the Double Mountain Fork watershed. It drains an area of approximately 4,850 square miles.

There are no published quality data on this subarea. A discharge gage was operated by the U. S. Geological Survey from 1939 to 1949, when the average flow was recorded as 1.7 cfs, with a range from zero to 3,150 cfs.

Ground waters in Subarea 1B are obtained from the Ogallala formation and Cretaceous sandstone and limestone. The cities of Levelland and Littlefield use the Ogallala formation. Lubbock and Slaton obtain their water from both the Ogallala formation and the Cretaceous rocks. Lubbock used over 19,000 acre-feet of this ground water during 1958. Samples collected during April, 1952, had the following quality analysis:

Analysis	Concentration (ppm)
Total Solids	943
pH	7.7
Alkalinity	310
Silica	54
Hardness	480
Calcium	72
Magnesium	76
Sodium	136
Iron	0.10
Sulfate	306
Chloride	103
Fluoride	3.0
Nitrate	4.0

Subarea 2A

Subarea 2A is the Salt Fork Brazos River watershed, draining about 2,600 square miles. Subarea 1A (White River) joins the Salt Fork at mile 113; Croton Creek at mile 64; and Dove Creek at mile 35.

There are chemical quality records for sampling stations at miles 55 and 29 on the Salt Fork, and mile 8 on Dove Creek. Discharge records are also available for the three stations.

The chemical quality of the water in the Salt Fork at mile 55 is poor, with total solids ranging from 934 to 33,700 ppm (avg. 2,610 ppm); chlorides from 110 to 17,800 ppm (avg. 1,160 ppm); sulfates from 141 to 12,600 ppm (avg. 412 ppm); and hardness from 214 to 4,160 ppm (avg. 583 ppm). Discharge at mile 55 was measured from December, 1949, to September, 1951. The average flow was approximately 134 cfs, ranging from no flow to 9,900 cfs.

At mile 35 on the Salt Fork, Dove Creek discharges an average 3.9 cfs. At a point eight miles upstream from the mouth, the chlorides ranged from 1,130 ppm to 159,000 ppm, with an average concentration of 40,600 ppm. Sulfates ranged from 1,100 ppm to 10,400 ppm.

Seven miles downstream from the mouth of Dove Creek, the average flow in Salt Fork during water year 1957-58 was 71.4 cfs, with a range from zero to 7,760 cfs. The quality is so poor that it cannot be used for any normal purpose. Total solids averaged 8,500 ppm, ranging from 2,670 ppm to 59,200 ppm; chlorides averaged 4,410 ppm, ranging from 1,220 to 27,100 ppm; sulfates averaged 826 ppm, ranging from 311 to 3,750 ppm; hardness averaged 1,100 ppm, ranging from 408 to 5,300 ppm.

Ground waters in Subarea 2A are obtained chiefly from alluvium and to a lesser extent from Triassic and Permian rocks. The city of Spur obtains its water from ten wells varying in depth from 40 to 50 feet. It used about 350 acre-feet during the year 1958. Chemical quality of samples collected from the ten wells during 1947-51 was in the following range:

Analysis	Concentration (ppm)
Total Solids	1010 - 2300
pH	7.3 - 8.0
Alkalinity	215 - 275
Silica	21 - 42
Hardness	420 - 891
Calcium	89 - 204
Magnesium	45 - 93
Sodium	177 - 400
Iron	0.06 - 7.0
Sulfate	252 - 847
Chloride	217 - 422
Fluoride	1.6 - 3.1
Nitrate	2.2 - 10.0

Subarea 2B

Subarea 2B is the downstream portion of Double Mountain Fork. In addition to the discharge from Subarea 1B, it drains an area of 1,780 square miles.

Records of chemical quality have been published for two stations, at miles 71 and 35. Corresponding discharge records are available for both stations.

Total dissolved solids at mile 71 averaged 812 ppm, with a range from 531 to 19,100 ppm; chlorides averaged 160 ppm, and ranged from 43 to 9,700 ppm; hardness averaged 308 ppm, and ranged from 144 to 2,640 ppm. The average flow for this period (1949-51) was 146 cfs.

At mile 35, the average discharge for the periods 1941-43, 1948-51, and 1957-58 was 179 cfs. The average flow during water year 1957-58 was 130 cfs. The average concentration of dissolved solids corresponding to this flow was 1,390 ppm; chlorides 265 ppm; sulfates 592 ppm; and hardness 632 ppm. Converted to tons per day, these records show that Double Mountain Fork discharged 488 tons of dissolved solids, 93 tons of chlorides, and 208 tons of sulfates daily to the Brazos River at mile 899.

Ground waters in Subarea 2B are obtained from Triassic and Permian rocks and the Ogallala formation. The city of Post, with nineteen wells (depth 100 to 121 feet), obtains water of the following quality:

Analysis	Concentration (ppm)
Total Solids	650
pH	7.9
Alkalinity	305
Silica	51
Hardness	305
Calcium	53
Magnesium	42
Sodium	116
Iron	0.09
Sulfate	132
Chloride	78
Fluoride	5.0
Nitrate	6.0

Subarea 2C

This is the upper portion of the Clear Fork, and drains an area of 2,220 square miles. Tributaries that discharge to Clear Fork in this subarea that have quality or discharge records include Bitter Creek, which joins the Clear Fork at mile 48.

Water quality records are available for two stations on Clear Fork in Subarea 2C, at miles 213 and 122. A discharge gage is operated at mile 133. Information on quality of waters has been obtained from the laboratory analyses of municipal water supplies with sources in tributary impoundments. These include the city of Sweetwater, which obtains its supply from Lake Trammel on Sweetwater Creek, and Abilene, which obtains its supply from Lakes Abilene, Kirby, and Ft. Phantom Hill.

The quality of waters in Subarea 2C varies widely, with one station at mile 213 indicating very poor mineral quality. Although there are no discharge data recorded for this station, the flow may be assumed to be negligible since the concentration at this uppermost station is never approached at any point downstream. Total solids at mile 213 range from 450 to 10,176 ppm (median 6,540); chlorides range from 80 to 3,800 ppm (median 2,000); and sulfates range from 74 to 2,220 ppm (median 1,630). At mile 133, the total solids range from 158 to 3,910 (median 260); chlorides from 17 to 438 (median 37); and sulfates from 139 to 610 (median 141). Sweetwater and Bitter Creeks have waters that are moderately hard (172 ppm), but otherwise of good quality, with only 232 ppm total dissolved solids. Similar chemical quality is shown in Lakes Abilene, Kirby, and Ft. Phantom Hill.

Subarea 2D

Subarea 2D is the lower portion of the Clear Fork, and drains an area of 3,544 square miles in addition to the upper Clear Fork (Subarea 2C).

Quality records are published for stations located at miles 58 and 3 and on Paint and Hubbard Creeks. Other quality data are available in the water supply records of Stamford (from Lake Stamford on Paint Creek), and Breckenridge (Clear Fork). Discharge records are available for miles 58, 26, 23, and 8. The gage at mile 58 has not been operated since 1950; at mile 26 since 1929; at mile 23 since 1951; and at mile 8 since 1925.

Water in the Clear Fork just above its point of discharge to the Brazos reflects pollution from oil field brines, with chlorides ranging from 52 to 2,600 ppm and dissolved solids from 198 to 6,240 ppm.

The waters of Clear Fork are basically good and would provide a dependable supply of good water if oil field brines are removed. Water resource planning should recognize that these waters have value for dilution of the poorer quality water found in the main stem of the Brazos. If Clear Fork water is impounded and used upstream, the quality of water downstream in the Brazos can be expected to deteriorate.

There is very little ground water available in the vicinity of the cities of Albany, Anson, Breckenridge, and Stamford. These cities all use surface water sources. The cities of Haskell and Rule obtain their supplies from the Seymour formation. The city of Rule utilizes a well 45 feet deep. Analysis of water from this well in April, 1946, showed the following quality:

Analysis	Concentration (ppm)
Total Solids	651
pH	7.6
Alkalinity	293
Silica	29
Hardness	388
Calcium	114
Magnesium	25
Sodium	74
Iron	0.08
Sulfate	68
Chloride	85
Fluoride	0.6
Nitrate	80.0

The above analysis reveals an excessive concentration of nitrate; Water Supply Paper No. 1069 shows even higher nitrates, with 152 ppm recorded for a sample collected on March 24, 1946. The city of Haskell, drawing from this same formation (Seymour), showed the following quality for a sample collected May, 1953 :

Analysis	Concentration (ppm)
Total Solids	1,308
pH	7.8
Alkalinity	270
Silica	26
Hardness	604
Calcium	130
Magnesium	68
Sodium	254
Iron	0.16
Sulfate	433
Chloride	309
Fluoride	1.20
Nitrate	100

The above analysis for the city of Haskell represents a composite from the distribution system. A sample collected from well No. 5 on March 17, 1944, showed similar concentrations, except for nitrates, which in the case of well No. 5 were 177 ppm.

Subarea 2E

Subarea 2E includes the furthest upstream reach of the Brazos River from mile 899 to mile 756. It receives the discharge from Double Mountain Fork (Subareas 1B and 2B) and Salt Fork (Subareas 1A and 2A) at its inception, mile 899, and the discharge from Clear Fork (Subareas 2C and 2D) at mile 760. Excluding the noted subareas, Subarea 2E drains 2,550 square miles.

Records of chemical quality are available for stations located at miles 832 and 808 on the main stem, and discharge records at miles 832 and 766.

Since the Brazos River is formed by the confluence of Double Mountain Fork and Salt Fork, its initial chemical quality is very poor from mile 899 to mile 760.

Although dilution water from Clear Fork (at mile 760) improves the quality of the Brazos River, the improvement is not sufficient to make the Brazos meet the adopted chemical criteria before leaving Subarea 2E.

Subarea 2F

Subarea 2F includes 236 miles of the main stem of the Brazos River, from mile 756 to mile 508. It drains 3,240 square miles in addition to the runoff from Subarea 2E. The only significant tributary is Palo Pinto Creek, which joins the Brazos River at mile 614. Possum Kingdom Reservoir is formed by a dam at mile 687; this is the first point on the Brazos main stem to be used as a municipal water supply (Mineral Wells augments its supply from Possum Kingdom).

Quality records are available for stations located at miles 758, 687, 667, 558, and mile 511. Discharge gages are operated at miles 758, 667, and on Palo Pinto Creek at mile PC7.

The quality of water entering Subarea 2F from Subarea 2E does not meet the adopted criteria: Total dissolved solids, 257-13,800 ppm (average 1,590); chlorides, 370-2,250 ppm (average 795); sulfates, 156-932 (average 400); hardness, 123-1,950 (average 444). Improvement in quality is effected by Possum Kingdom Dam.

BRAZOS RIVER WATER QUALITY ABOVE AND BELOW POSSUM KINGDOM DAM*

	Mile 758	Mile 687	Mile 667
Total Dissolved Solids (ppm)	1,590	1,180	1,140
Chlorides (ppm)	795	443	220
Sulfates (ppm)	400	248	224
Hardness (ppm)	444	382	

*Mile 687.

Palo Pinto Creek discharged about 190 cfs to the Brazos at mile 614 during 1957-58. There are no quality records published for this tributary.

The Brazos River discharged about 2,000 cfs from Subarea 2F to Subarea 3C during water year 1957-58, containing approximately 1,080 ppm dissolved solids, 310 ppm chlorides, and 175 ppm sulfates.

Subarea 3A

Subarea 3A includes the Leon River and its tributaries. Confluence of the Leon River with the Lampasas River forms the Little River. Area 3A covers 3,513 square miles and has two major impoundments: Leon Reservoir at mile 296 and Belton Reservoir at mile 16.7, both on the Leon River.

A chemical quality sampling station was operated by the U. S. Geological Survey from 1950-53 at mile 299. The Texas Department of Health has operated quality monitoring stations at miles 237, 180, 104, and 10 since 1957. United States Geological Survey discharge gages are, or have been, located at miles 237, 180, 104, and 13.

Quality of waters in the Leon River can be evaluated in terms of the uses made of Leon and Belton Reservoirs. Leon Reservoir was placed in operation in April, 1954, to furnish a municipal water supply for Ranger, Olden, and Eastland, Texas. Its capacity at the service spillway is 27,290 acre-feet. The chemical quality, as recorded by the U. S. Geological Survey from 1950-53 at mile 299 is very satisfactory, with the following range in concentrations: dissolved solids, 77-316 ppm; chlorides, 3-47 ppm; sulfates, 4-17 ppm; and hardness, 66-100 ppm.

Belton Reservoir, at mile 16.7, was placed in operation on March 4, 1954. It has a maximum capacity of 1.88 milllion acre-feet. Although designed primarily for flood control and conservation, 12,000 acre-feet of storage have been allocated for use by Fort Hood. Discharge from the dam during 1957-58 ranged from 1.0 to 6,260 cfs, with a weighted average of 1,003 cfs. Quality of water in Belton Reservoir is indicated by analysis of the raw water supply for the city of Killeen: total solids, 320 ppm; chlorides, 38 ppm; and sulfates, 35 ppm. The city of Temple used an average 6 cfs from Belton Reservoir during 1957-58.

The city of DeLeon obtains its ground water supply (about 220 acre-feet during 1958) from the Trinity sands. DeLeon's wells, drilled from 150 to 200 feet, produced water with the following quality range:

Analysis	Concentration (ppm)	
	Well #8	Well #11
Silica	12	12
Iron	0.03	0.04
Calcium	150	162
Magnesium	22	20
Sodium	17	12
Potassium	5.8	8.4
Bicarbonate	296	390
Sulfate	33	86
Chloride	160	242
Fluoride	0	0
Nitrate	8.2	6.0
Dissolved Solids	675	912
Hardness	465	486

Subarea 3B

Subarea 3B drains 1,640 square miles into the North and South Bosque Rivers, which join and discharge to the Brazos River at mile 410.

There is only one quality station in this area, at mile 36 on the North Bosque. The quality at this station is good, with an average dissolved solids of 293 ppm, chlorides 35 ppm, and sulfates 37 ppm.

Based on the discharge records for two stations, the flow from the North Bosque is about 351 cfs, and the South Bosque about 190. Thus, Subarea 3B may be expected to discharge about 540 cfs of good quality water to the Brazos River at mile 410.

Ground waters in Subarea 3B are obtained from the Trinity sands. The cities of Stephenville and McGregor used 640 and 280 acre-feet respectively during 1958 of the quality shown below:

Analysis	Concentration (ppm)	
	Stephenville	McGregor
	Depth: 370'	1000-1250'
Total Solids	464	830
pH	6.8	8.3
Alkalinity	290	375
Silica	14	18
Hardness	329	54
Calcium	79	5
Magnesium	32	10
Sodium	46	292
Iron	0.12	0.14
Sulfate	46	199
Chloride	64	75
Fluoride	0.2	1.3
Nitrate	---	---

Subarea 3C

The Brazos River flows from mile 508 to 406 in this subarea, and receives the runoff from Subarea 3B (Bosque River) at mile 410.

There are chemical quality sampling stations at mile B511, B442, and B440 on the main stem. Discharge stations on tributaries that join the Brazos in this reach, with their corresponding river mile locations are: Paluxy Creek, B506, Pa4.7; Nolands River, B472, Nr9; and Aquilla Creek, B416, Aq17. The only tributary that has a quality measurement station is Paluxy Creek.

In water year 1957-58, the average flow in the Brazos River as it entered Subarea 3C was 2,020 cfs, with a range during the year from 186 cfs to 34,600 cfs. The flow has been largely controlled by Possum Kingdom Dam since 1941.

Quality determinations made by the Texas Department of Health at mile B511 show that the water entering Subarea 3C just exceeds the U. S. Study Commission - Texas quality criteria, with the following concentrations of minerals corresponding to 1,690 cfs discharge: total solids 1080 ppm; chlorides 310 ppm; and sulfates 175 ppm.

Paluxy Creek discharged about 92 cfs to the Brazos at mile B506; this water is of good quality, containing 310 ppm dissolved solids, 26 ppm chlorides, and 38 ppm sulfates.

Thirty-four miles downstream from the mouth of Paluxy Creek, Nolands River discharged about 158 cfs to the Brazos River. There are no published quality records for the Nolands River.

Whitney Reservoir has its dam at mile B442. The effect of this 642,200 acre-feet impoundment is definitely beneficial, if judged by the average quality as measured 3.4 miles downstream from the dam. Here, the dissolved solids are reduced to 604 ppm, the chlorides to 170 ppm, and the sulfates to 122 ppm. The water is still very hard, however, with 249 ppm corresponding to the average flow of 2,322 cfs.

Aquilla Creek discharged about 179 cfs of undetermined quality water to the Brazos at mile 416 during 1957-58.

Ground waters in Subarea 3C are obtained from the Trinity, Paluxy, and Woodbine sands. The city of Cleburne obtains its supply (1,650 acre-feet during 1958) from the upper and lower Trinity sands as well as the Paluxy sands. Analysis of Cleburne's water supply in 1952 showed the following range of quality:

Analysis	Concentration (ppm)
Total Solids	554-640
pH	8.1-8.6
Alkalinity	340-420
Silica	10- 21
Hardness	16- 71
Calcium	7- 17
Magnesium	1- 10
Sodium	216-299
Iron	0.08-0.52
Sulfate	69-133
Chloride	36- 50
Fluoride	0.7-1.3
Nitrate	1.3-1.8

Subarea 3D

Subarea 3D includes the Lampasas River, Little River, and subtributaries. Area 3A (Leon River) discharges to Area 3D at the junction of Lampasas and Little Rivers. Area 3D covers 2,655 square miles.

There are two quality monitoring stations on the Lampasas River, at miles 75 and 15. Two similar stations are located on Little River, at miles 50 and 32.5. The U. S. Geological Survey operates, or has operated discharge gages on the Lampasas River at mile 41, and on the Little River at miles 97 and 33. Elm Creek discharges to the Little River at mile 27. Discharge was measured on Elm Creek and North Elm Creek from 1934-36. There are no published quality records for the Elm Creek watershed.

The upper Lampasas has many small diversions for irrigation and municipal supplies. Its chemical quality at mile 75, as indicated by the median values in this quality monitoring station there, is good: total solids, 477 ppm; chlorides, 104 ppm; and sulfates, 29 ppm. Average discharge for water year 1957-58 was 497 cfs.

Deterioration in quality takes place during the 60 miles of water travel from mile 75 to mile 15. Median values at the downstream monitoring station were: total solids, 1,240 ppm; chlorides, 330 ppm; and sulfates, 170 ppm. This quality is also considerably worse at this station than it was fourteen years previous. The U. S. Geological Survey station that was operated from 1943-44 showed a range of values, the worst of which were better than the recent median: total solids, 314-435 ppm; chlorides, 64-122 ppm; and sulfates, 30-34 ppm. The water was very hard, even in 1943-44, ranging from 222 to 265 ppm. Discharge at mile 41 averaged 497 cfs in 1957-58 and 278 cfs from 1924-58.

The Little River is formed at the confluence of Lampasas and Leon Rivers. The origin of the river at this point is about 102 miles upstream from the Brazos River.

Quality at mile 50 as indicated by the median values recorded at the quality monitoring station there is good: total solids, 350 ppm; chlorides, 50 ppm; and sulfates, 38 ppm. The quality is equally good at mile 32.5. Discharge during 1957-58 averaged 3,366 cfs; from 1916-58, it averaged 1,739 cfs.

There are many small diversions for irrigation and municipal supplies that affect low flows. The Aluminum Company of America diverted 4,070 acre-feet from the Little River for use at their Rockdale plant.

The Little River discharged more than 1,800 cfs of good quality water (as described above) to the Brazos River during 1957-58.

The city of Belton obtained about 1,060 acre-feet of ground water from the Trinity group during 1958. Belton's wells Nos. 2 and 3 are about 1,175 feet deep. The quality of water from these wells as sampled in 1949 showed the following range of quality:

Analysis	Concentration (ppm)
Total Solids	1,376-1,395
pH	7.8- 7.8
Alkalinity	365- 370
Silica	15- 16
Hardness	106- 116
Calcium	29- 30
Magnesium	8- 10
Sodium	434- 466
Iron	0.18- 0.48
Sulfate	257- 258
Chloride	298- 344
Fluoride	2.2- 2.2

Subarea 3E

Subarea 3E is the San Gabriel watershed. It drains 1,327 square miles and discharges to the Little River at mile 44.

There is one quality monitoring station at mile 56 and two gaging stations, at miles 56 and 35. The station at mile 35 was operated from 1924 to 1934.

Based on the records for the above stations, the average flow of 244 cfs was good quality water: total solids, 342 ppm; chlorides, 24 ppm; and sulfates, 15 ppm.

Ground waters in Subarea 3E are obtained from the Edwards limestone and Trinity group. The city of Georgetown obtained about 870 acre-feet of water from Edwards limestone during 1958. Samples collected in 1953 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	244-492
pH	7.2-8.9
Alkalinity	115-300
Silica	8- 16
Hardness	161-372
Calcium	43-116
Magnesium	13- 22
Sodium	19- 25
Iron	0.04-1.8
Sulfate	20- 37
Chloride	21-128
Fluoride	0.1-0.2
Nitrate	11- 18

The city of Taylor utilized about 1,110 acre-feet of water from the Trinity group during 1958. Taylor's wells were very deep, from 3,260 to 3,335 feet. Samples collected from 1942 to 1953 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	1,420
pH	7.9
Alkalinity	375
Silica	36
Total Hardness	72
Calcium	14
Magnesium	9
Sodium	466
Iron	0.2
Sulfate	370
Chloride	231
Fluoride	1.8

Subarea 3F

Subarea 3F is the Yegua Creek watershed and drains 1,331 square miles. Yegua Creek is about 42 miles in length and originates at the confluence of Middle Yegua (43 miles) and First Yegua (33 miles) Creeks.

There are no published quality records for this subarea. A single discharge gage at mile 18 of the Yegua Creek showed an average flow during 1957-58 of 644 cfs. The average flow at this station from 1923-58 was 285 cfs, with a range from zero to 56,800 cfs.

Ground waters in Subarea 3F are obtained from the Wilcox group and the Sparta sand. The city of Rockdale utilized 520 acre-feet of this ground water during 1958. Rockdale's wells, which are about 200 feet deep, showed the following quality in samples collected during 1953:

Analysis	Concentration (ppm)
Total Solids	185-506
pH	6.0-8.0
Alkalinity	30- 85
Silica	25- 47
Hardness	72-253
Calcium	19- 80
Magnesium	6- 16
Sodium	24- 62
Iron	0.11-2.40
Manganese	0.15-
Sulfate	23- 49
Chloride	39-185
Fluoride	0.10-
Nitrate	10- 20

Subarea 3G

The Brazos River flows from mile 406 to mile 232 in this 3,374 square mile drainage area. The following subareas discharge to this reach of the main stem: 3A, 3D, and 3E (Leon, Lampasas, San Gabriel, and Little Rivers) at mile 315; 3F (Yegua Creek) at mile 248; and 3H (Navasota River) at mile 233.

There are chemical quality sampling stations at mile B404, B369, B322, B311, B290, and B285. The first three stations have been operated by the Texas Department of Health since 1957; the station at B285 was operated by the Geological Survey from 1946-51.

Subarea 3G received approximately 2,900 cfs from Subarea 3C during 1957-58. The chemical quality of this influent water as described in Subarea 3C was almost within the U. S. Study Commission - Texas criteria. Except for the contributing areas noted above, there are no significant tributaries in this reach.

By the time the Brazos River has passed through Subarea 3G and enters Subarea 4A, its flow has increased to about 11,000 cfs. The chemical quality has improved to the extent that it is well within the U. S. Study Commission - Texas criteria: dissolved solids 405 ppm; chlorides 108 ppm; and sulfates 53 ppm.

The city of Waco discharged about 10 cfs of sewage effluent to the Brazos at mile 402.

Waco obtains its water from surface sources.

Bryan-College Station obtained about 5,880 acre-feet of ground water from Sparta-Wilcox sands during 1958. Bryan's wells vary from 465 to 686 feet deep. According to analyses made on samples collected from 1939 to 1953, this water had the following quality:

Analysis	Concentration (ppm)
Total Solids	183-244
pH	7.7-8.5
Alkalinity	120-175
Silica	13- 35
Hardness	3- 23
Calcium	1- 5
Magnesium	0.07-3.0
Sodium	65- 91
Iron	0.04-1.0
Sulfate	1.0-8.0
Chloride	18- 28
Fluoride	0.2-1.0
Nitrate	1.1-1.6

The city of Hearne obtained about 720 acre-feet from the Wilcox group. The wells of Hearne varied in depth from 748 to 1,442 feet. Analysis of these wells showed the following quality during 1950-51:

Analysis	Concentration (ppm)
Total Solids	452-510
pH	8.1-8.4
Alkalinity	340-348
Silica	16- 58
Total Hardness	30- 51
Calcium	7- 12
Magnesium	3- 5
Sodium	169-187
Iron	0.12-1.60
Sulfate	3- 7
Chloride	50- 57
Fluoride	0.2-

Subarea 3H

Subarea 3H is the Navasota River watershed. The Navasota River is about 197 miles long and drains 2,178 square miles. It discharges to the Brazos River at mile 233.

There are three quality monitoring stations on the Navasota River, at miles 105, 68, and 6. Discharge gages are opereated at miles 105 and 68. The average flow at mile 105 was 554 cfs during 1957-58. Median chemical quality met the adopted criteria, with total solids 400 ppm, chlorides 98 ppm, and sulfates 55 ppm. The flow increased to 759 cfs at the next downstream station (mile 68), with no appreciable changes in quality. Average discharge from 1951-58 was 410 cfs. At mile 6, the quality was better than either of the two upstream stations: total solids 255 ppm, chlorides 60 ppm, and sulfates 43 ppm.

Although there is much diversion on the Navasota for municipal use and irrigation, the median quality of the approximated 500 cfs discharged to the Brazos River at mile 233 is good.

Ground waters in Subarea 3H are obtained from fractured limestone of the Midway group, Catahoula sandstone, Wilcox, Carrizo, Sparta, and alluvium. Mexia obtained 905 acre-feet from the fractured limestone of the Midway group. Mexia's wells vary in depth from 320 to 450 feet. Samples from these wells showed the following quality from 1950-52:

Analysis	Concentration (ppm)
Total Solids	335-740
pH	7.0-7.9
Alkalinity	280-345
Silica	20- 27
Hardness	84-167
Calcium	22- 52
Magnesium	7- 12
Sodium	92-224
Iron	0.09-1.1
Sulfate	8- 22
Chloride	25-224
Fluoride	0.1-0.5
Nitrate	1.6-4.4

Navasota obtained 420 acre-feet from the Catahoula sandstone during 1958. Its three wells varied from 296 to 315 feet in depth. Quality of samples collected from 1948 to 1950 had the following analysis:

Analysis	Concentration (ppm)
Total Solids	615-678
pH	7.3-8.0
Alkalinity	425-460
Silica	33- 36
Hardness	82- 93
Calcium	26- 29
Magnesium	4- 5
Sodium	207-236
Iron	0.1-4.9
Sulfate	3- 7
Chloride	71- 92
Fluoride	0.4-0.5

Subarea 4A

The Brazos River flows from mile 232 to the Gulf in this 2,000 square mile drainage area.

There are five quality sampling stations located on the main stem at miles 196, 93, 57, 30, and mile 9. Discharge gages are operated at miles 196, 93, and 67. No other subareas discharge to the Brazos River in this reach.

The chemical quality at mile 196 is within the limits of the adopted criteria: total solids 144-828, median 405; chlorides 12-240, median 108; and sulfates 25-129, median 53.

Eighty-three miles downstream, the American Canal Company's Canal used an average 96 cfs of water for irrigation. Twenty-three miles further downstream, the Richmond Irrigation Company used 51 cfs of Brazos River water. Average discharge two miles below the Richmond Irrigation Company's diversion canal, at mile 93, was 11,870 cfs. Quality at this point was well within the adopted criteria, with total solids 303 ppm, chlorides 57 ppm, sulfates 50 ppm, and hardness 166 ppm.

The flow in the Brazos decreased from 11,870 cfs at mile 93 to 11,630 cfs at mile 67. There is no quality data for the latter station. At mile 58, Big Creek discharges about 50 cfs to the Brazos. The quality monitoring station at mile 57 indicates uniformly good chemical quality water. At mile 30, the median values are still good (total solids 366, chlorides 68, and sulfates 61), but maximum values of 5,010, 285, and 139 respectively indicate some effect from salt water intrusion. At mile 9, salt water from the Gulf has a pronounced affect on quality; total solids ranged from 225 to 108,000 ppm, with a median of 4,410 ppm; chlorides ranged from 40 to 8,800 ppm, median 1,880; sulfates ranged from 34 to 1,180, median 274 ppm.

Ground waters in Subarea 4A are obtained from Oakville sandstone, varying depths of Beaumont fresh water sands, and the Lissie-Willis-Goliad aquifer.

Brenham obtained 920 acre-feet from the Oakville sandstone during 1958. Brenham's wells varied in depth from 198 feet to 1,515 feet. The deep well had the best quality, with hardness of 87 ppm, as contrasted with 334 and 336 ppm in the 200 foot wells. Total dissolved solids ranged from 425 to 473 ppm. In all other aspects, the water met the current drinking water standards.

The cities of Brazoria, Freeport, Rosenberg, West Columbia, and Richmond all obtain their ground water supplies from varying depths of the Beaumont fresh water sands. Of these cities, Freeport used the greatest amount of ground water during 1958 -- 1,340 acre-feet. The following analysis of Freeport's water is listed here as typical of the Beaumont fresh water sands:

Analysis	Concentration (ppm)
Total Solids	850-974
pH	7.5-8.1
Alkalinity	485-505
Silica	16- 21
Total Hardness	127-173
Calcium	26- 38
Magnesium	15- 22
Sodium	279-318
Iron	0.1-2.2
Manganese	Less than 0.05
Sulfate	3- 12
Chloride	167-266
Fluoride	0.5-0.6
Nitrate	Less than 0.4 to 20.0

Subarea 4B

Ground waters in Subarea 4B are obtained from the Beaumont fresh water sands which vary in thickness from 400 to 1,150 feet. Cities obtaining water from this source include: Alvin, Alta Loma, Arcadia, Bacliff-San Leon, Dickinson, Friendswood, Hitchcock, Kemah, League City, Galveston, Lamarque, Texas City, and Lake Jackson. A description of Galveston's water supply is shown here. Wells varied in depth from 712 to 888 feet.

Analysis	Concentration (ppm)
Total Solids	714-1755
pH	7.9- 8.1
Alkalinity	270- 290
Silica	16- 40
Hardness	66- 281
Calcium	17- 64
Magnesium	5- 32
Sodium	239- 568
Iron	0.07-0.25
Manganese	Less than 0.05
Sulfate	2- 38
Chloride	211- 852
Fluoride	0.4- 0.6
Nitrate	Less than 0.4

STATEMENT OF TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE BRAZOS RIVER BASIN*

Total Number of Sample Stations = 37
Total Number of Samples Taken = 2099
Average Samples/Station = 57

Total Samples "Good"	1314 for 63%
Total Samples "Poor" Organically and Chemically	42 for 2%
Total Samples "Poor" Organically Only	53 for 2%
Total Samples "Poor" Chemically Only	690 for 33%

Remarks: As might be expected, the results of the sampling program indicate that chemical sources predominate in affecting the water quality of the Brazos Basin. This is further substantiated in examining the results of the samples taken in the upper reaches of the Basin. For example, the 10 stations starting at the U. S. Highway 67 bridge northeast of Glen Rose in Somervell County and continuing downstream were sampled 560 times with 438 (78%) being "Poor Chemically." This number also represents 64% of the "Poor" Chemically samples of the entire Basin. Organic contribution does not appear to be a major influencing factor in the overall Basin.

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*Presented to U. S. Study Commission - Texas, June 6, 1960.

TABLE B-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE BRAZOS RIVER BASIN

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1-A	White River	W112 SF113 B899	---	156	1939-49	---	---	---
2A	Salt Fork	SF59 B899	4,260	157	1949-51	1949-51	---	---
2A	Dove Creek	Do13.5 SF35 B399	---	A	1956-	1956-		
2A	Salt Flat Creek	SFC0 Do10.5	---	B	1956-	1956-	---	---
2A	Dove Creek	Do9.8	---	C	1956-	1956-	---	---
2A	Dove Creek	Do8.3	---	D	1956-	1956-	---	---
2A	Haystack Creek	HC0.1 Do8.2	---	E	1956-	1956-		
2A	Dove Creek	Do8.0	69	158	1956-	1956+		

Table B-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	THD Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2A	Salt Fork	SF29	4,830	159	1923-25 1939-	1941-43 1948-51 1956-57	37	1957-60
1B	Double Mountain Fork	DM208 B899	---	153	1939-49	---	---	---
2B	Double Mountain Fork	DM71	7,740	154	1949-51	1949-50 1951	---	---
2B	Double Mountain Fork	DM35	7,980	155	1924-34 1939-	1941-43 1948-51 1956-57	36	1957-60
2E	Brazos River	B832	14,490	160	1923-	1941-43	---	---
2E	Brazos River	B808	---	---	---	---	17	1957-60
2E	Brazos River	B766	15,730	161	1916-20	---	---	---
2C	Clear Fork	CF213 B760	---	---	---	---	35	1957-60
2C	Bitter Creek of Sweetwater Creek of Clear Fork (Lake Sweetwater)	BC9 SW9 CF184	104	162	1936-	---	---	---

Table B-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2C	Elm Creek (Ft. Phantom Hill Res.)	EC4 CF141	478	163	1940-	---	---	---
2C	Clear Fork	CF133	2,220	164	1924-	---	---	---
2D	Clear Fork	CF122	---	---	---	---	34	1957-60
2D	Paint Creek California Creek (Lake Stamford)	PC2 CF80	360	165	1953-	---	---	---
2D	Paint Creek	PC0	879	166	1949-51	1949-51	---	---
2D	Clear Fork	CF58	3,974	167	1924-	1949-51 1941-42 1952	33	1957-60
2D	Clear Fork	CF26	4,323	168	1921-29	---	---	---
2D	Hubbard Creek	HC8 CF25	1,087	169	1955-	1955-57	---	---
2D	Clear Fork	CF23	5,658	170	1916-20 1924-25 1928-51	---	---	---
2D	Clear Fork	CF3	---	---	---	---	32	1957-60

Table B-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2F	Brazos River	B758	21,600	171	1938-	1942-48	16	1957-60
2F	Brazos River (Possum Kingdom Res.)	B687	22,550	172	1941-	1942-57	---	---
2F	Brazos River	B667	22,760	173	1924-	---	15	1957-60
2F	Palo Pinto Creek	PPC7 B614	567	174	1924-25 1951-	---	---	---
2F	Brazos River	B558	---	---	---	---	14	1957-60
2F	Brazos River	B511	---	---	---	---	13	1957-60
3C	Brazos River	B509	24,840	175	1923-	---	---	---
3C	Paluxy Creek	Pa4.7 B506	399	176	1923-25 1947-	---	31	1957-60
3C	Nolands River	NR9 B472	276	177	1924-25 1947-	---	---	---
3C	Brazos River (Whitney Res.)	B442	26,170	178	1951-	---	---	---
3C	Brazos River	B440	---	---	---	---	12	1957-60
3C	Brazos River	B439	26,190	179	1938-	1947-57	---	---

Table B-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3C	Aquilla Creek	Aq17 B416	309	180	1929-	---	---	---
3B	Green Creek North Bosque River Bosque River Brazos River	NB115 BR6 B410	3.18	181	1955-	---	---	---
3B	North Bosque River Bosque River Brazos River	NB43 BR6 B410	988	182	1923-	---	---	---
3B	North Bosque River	NB36 BR6 B410	---	---	---	---	30	1957-60
3B	South Bosque River	SB3	388	183	1924-30	---	---	---
3G	Brazos River	404	28,500	184	1898-	---	11	1957-60
3G	Foster Branch Cow Bayou Brazos	FoB1 C11 B370	5.25	185	1956-	---	---	---
3G	Cow Bayou	C11 B370	79.6	186	1954-	---	---	---

Table B-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3G	Brazos River	B369	---	---	---	---	10	1957-60
3G	Brazos River	B368	29,150	187	1938-51	---	---	---
3G	Deer Creek	DC6 B367	81.8	188	1934-36	---	---	---
3G	Brazos River	B322	---	---	---	---	9	1957-60
3A	Leon River Little River Brazos River	Le299 Li102 B315	---	---	---	1950-53	---	---
3A	Leon River (Leon Res.)	Le296	259	189	1955-	---	---	---
3A	Leon River	Le237	1,242	190	1939-	---	27	1957-60
3A	Leon River	Le180	1,861	191	1925-31	---	26	1957-60
3A	Leon River	Le104	2,279	192	1950-	---	25	1957-60
3A	Cowhouse Creek	CoC90 Le21 Li102	475	193	1950-	---	---	---
3A	Cowhouse Creek	CoC21	---	194	1924-25 1939-42	---	---	---

Table B-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3A	Leon River (Belton Res.)	Le16.7	3,499	195	1954-	---	---	---
3A	Leon River	Le13	3,513	196	1923-	1936-47	---	---
3D	Leon River	Le10	---	---	---	---	24	1957-60
3D	Lampasas River	La75 Li102 B315	---	---	---	---	29	1957-60
3D	Lampasas	La41	1,242	197	1924-	---	---	---
3D	Lampasas	La15	---	---	---	1943-44	28	1957-60
3D	Little River	Li97	5,253	198	1923-29	---	---	---
3E	Little River	Li50	---	---	---	---	22	1957-60
3E	San Gabriel River	SG56 Li44	415	199	1924-25 1934-	---	23	1957-60
3E	San Gabriel River	SG35	602	200	1924-34	---	---	---
3E	Brushy Creek San Gabriel River	BrC31 SG6	198	201	1924-26	---	---	---
3D	Little River	Li33	7,000	202	1916-	---	---	---
3D	Little River	Li32.5	---	---	---	---	21	1957-60

Table B-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3D	Elm Creek	EC28 Li27	68.5	203	1934-36	---	---	---
3D	Elm Creek	EC17	166	204	1934-36	---	---	---
3D	North Elm Creek Elm Creek	NE8 EC7	---	205	1934-36	---	---	---
3G	Brazos River	311	---	---	---	---	8	1957-60
3G	Brazos River	290	---	---	---	---	7	1957-60
3G	Brazos River	285	38,400	206	1899-02 1918-	1946-51	---	---
3F	Yegua Creek	YC18 B248	990	207	1924-			
3H	Brazos River	B236	---	---	---	---	6	1957-60
3H	Navasota River	Na105	949	208	1924-	---	20	1957-60
3H	Navasota River	Na68	1,439	209	1951-	---	19	1957-60
3H	Navasota River	Na6 B233	---	---	---	---	18	1957-60

Table B-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
4A	Brazos River	B196	42,640	210	1938-	---	5	1957-60
4A	American Canal	AC1 B113	---	211	1931-54 1957-	---	---	---
4A	Richmond's Irr. Canal	RI1.5 B95	---	212	1931-54 1956-	---	---	---
4A	Brazos River	B93	44,020	213	1903-06 1922-	1945-57 1941-45	4	1957-60
4A	Brazos River	B67	44,100	214	1949-	---	---	---
4A	Big Creek	BC21 B58	37.6	215	1947-50 1952-	---	---	---
4A	Fairchild Big Creek	FC3 BC20	24.9	216	1947-54	---	---	---
4A	Big Creek	BC19 B58	112	217	1947-50	---	---	---
4A	Dry Creek Big Creek	DC15 BC3	10.3	218	1947-50 1956-58	---	---	---
4A	Brazos River	B57	---	---	---	---	3	1957-60
4A	Brazos River	B30	---	---	---	---	2	1957-60
4A	Brazos River	B9	---	---	---	---	1	1957-60

TABLE B-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE BRAZOS RIVER BASIN

Bra-1	Brazoria County	Bridge, State Hwy. 36 at Velasco
Bra-2	Brazoria County	Bridge, State Hwy. 35 at East Columbia
Bra-3	Fort Bend County	End of County road running through South Thompson Oil Field and ending at Brazos River E of South Thompson
Bra-4	Fort Bend County	Bridge, U. S. Hwy. 59 at Richmond (No. 42)
Bra-5	Waller County	Bridge, U. S. Hwy. 290 W Hempstead (No. 39)
Bra-6	Grimes County	Bridge, State Hwy. 90 W Navasota
Bra-7	Brazos County	Bridge, State Hwy. 21 W Bryan (No. 35)
Bra-8	Milam County	Bridge, U. S. Hwy. 79 W Hearne
Bra-9	Milam County	Bridge, U. S. Hwy. 190 NW Hearne
Bra-10	Falls County	Bridge, State Hwy. 7 W Marlin
Bra-11	McLennan County	Bridge, Washington Street Waco (No. 23)
Bra-12	Bosque County	Downstream side Whitney Dam, State Hwy. 22 near Whitney (No. 18)
Bra-13	Somervell County	Bridge, U. S. Hwy. 67 NE Glen Rose (No. 14)
Bra-14	Hood County	Bridge, U. S. Hwy. 377 at Granbury
Bra-15	Palo Pinto County	Bridge, F. M. 4 N Palo Pinto (No. 12)
Bra-16	Young County	Bridge, State Hwy. 67 NE Southbend (No. 10)
Bra-17	Baylor County	Bridge, U. S. Hwy. 277 at Seymour (No. 4)
Bra-18	Grimes County	Bridge, Navasota River, State Hwy. 90 W Navasota
Bra-19	Brazos County	Bridge, Navasota River, U. S. 190 E Bryan (No. 38)
Bra-20	Robertson County	Bridge, Navasota River, U. S. Hwy. 79 NE Easterly (No. 37)

Table B-2a (Continued)

Bra-21	Milam County	Bridge, Little River, U. S. Hwy. 77 SE Cameron (No. 34)
Bra-22	Milam County	Bridge, Little River, F. M. 486 W Cameron
Bra-23	Williamson County	San Gabriel River at Georgetown below juncture of N and S San Gabriels 100 feet downstream from M-K-T Railroad bridge (No. 33)
Bra-24	Bell County	Bridge, Leon River, U. S. Hwy. 81 E Belton (No. 31)
Bra-25	Coryell County	Bridge, Leon River, U. S. Hwy. 34 at Gatesville (No. 28)
Bra-26	Hamilton County	Bridge, Leon River, U. S. Hwy. 281 N Hamilton
Bra-27	Comanche County	Bridge, Leon River, U. S. Hwy. 377 NE Comanche (No. 27)
Bra-28	Bell County	Bridge, Lampasas River, U. S. Hwy. 81 S Belton
Bra-29	Lampasas County	Bridge, Lampasas River, U. S. Hwy. 190 at Kempner
Bra-30	Bosque County	Bridge, N Bosque, F. M. 215 at Clifton (No. 22)
Bra-31	Somervell County	Bridge, Paluxy Creek, U. S. Hwy. 67 SW Glen Rose (No. 15)
Bra-32	Young County	Bridge, Clear Fork Brazos River, F. M. 701 two miles E Eliasville (No. 10)
Bra-33	Shackelford County	Bridge, Clear Fork Brazos River, U. S. Hwy 283 at Fort Griffin (No. 8)
Bra-34	Shackelford County	Bridge, Clear Fork Brazos River, U. S. Hwy. 380 at Leuders E Oil Field
Bra-35	Fisher County	Bridge, Clear Fork Brazos River, State Hwy. 70 N Roby
Bra-36	Stonewall County	Bridge, Double Mountain Fork Brazos, U. S. Hwy. 83 S Aspermont (No. 1)
Bra-37	Stonewall County	Bridge, Salt Fork Brazos, U. S. Hwy. 83 N Aspermont (No. 3)

TABLE B-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL IN THE BRAZOS RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 1A									
SALT FORK	B899								
WHITE RIVER	SF113								
Farwell	W220	1,325	Wells	0.21	---	---	---	---	---
Bovina	W214	1,140	Wells	0.31	500	Land irr.	---	---	---
Plainview	W112	21,000	Wells	4.0	12,000	White Ri. & land irr.	440	---	---
Hale Center	W105	2,500	Wells	0.25	1,000	Wet weather lake	439	423	448
Lockney	W90	2,200	Wells	0.33	1,300	Land irr. & dry lake bed	477	---	461
Floydada	W78	4,500	Wells	0.50	2,500	Dry lake (no outlet)	416	390	430
Dougherty	W67	200	Wells	0.025	---	---	400	---	---

Table B-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
CRAWFISH DRAW	W58								
Petersburg	CD25	1,250	Wells	0.25	---	Lagoon & land irr.	415	---	---
Ralls	W48	2,200	Wells	0.50	1,100	Dry lake	394	---	---
Crosbyton	W44	2,200	Wells	0.21	1,400	Creek	---	---	---
Subarea 2A									
DUCK CREEK	SF89								
Spur	DC30	3,300	Wells	0.31	2,500	Spade Draw	2,300	1,010	---
Jayton	SF83	650	Wells	0.08	---	---	---	---	---
DOVE CREEK	SF35								
SALT FLAT CREEK	DO105								
HAYSTACK CREEK	DO8.2								

Table B-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 1B									
DOUBLE MOUNTAIN FORK	B899								
Muleshoe	DM321	4,500	Wells	0.50	2,500	Lagoon & Evap. lake	865	768	---
Sudan	DM288	1,500	Wells	0.25	1,000	Artif. lake	542	---	---
Amherst	DM281	1,100	Wells	0.16	600	Dry lake (no outlet)	---	---	---
Littlefield	DM270	7,300	Wells	1.10	5,000	Land irr.	600	533	---
Abernathy	DM237	2,500	Wells	0.41	700	Dry lake (no outlet)	---	---	---
Idalou	DM215	1,000	Wells	0.175	500	Dry lake (no outlet)	613	---	460
YELLOW HOUSE CREEK	DM208								
Levelland	YH35	11,000	Wells	2.40	7,500	Dry lake	695	669	---
Shallowater	YH17	600	Well	0.125	---	---	---	---	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
Lubbock	DM208	136,000	Wells	14.60	123,500	Lagoon & irr. & dry lake	1,035	734	943
Slaton	DM186	5,800	Wells	0.70	4,000	Double Mountain Fork	900	634	---
Wilson	DM183	450	Wells	0.04	---	---	582	---	---
TRIB. OF DOUBLE MOUNTAIN FORK	DM180								
Lorenzo	T18	1,125	Wells	0.21	500	Dry lake & land irr.	386	---	---
Subarea 2B									
SAND CREEK	DM139								
Post	SC15	4,000	Wells	1.0	3,100	Sand Cr. & Land irr.	700	480	650
TRIB. OF DOUBLE MOUNTAIN FORK	DM120								
Tahoka	T70	3,000	Wells	0.30	2,500	Lagoon & land irr.	---	---	499
TANK CREEK	DM9								
Aspermont	TC20	1,500	Wells	0.175	800	Cr. to Plum River	---	---	2,662

Table B-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Rule	DM9	1,600	Wells	0.21	1,100	Cr. to Brazos River	---	---	651
Subarea 2E									
BRAZOS RIVER									
Rochester	B890	810	Wells	0.12	300	Lagoons	---	---	514
Knox City	B887	1,950	Wells	0.31	1,100	Dry lake	1,075	---	1,160
Benjamin	B885	525	Wells	0.048	----	---	2,240	330(S)	---
Munday	B862	2,500	Wells	0.40	1,800	Lagoon & land irr.	1,772	1,030	---
LAKE CREEK	B844								
Weinert	LC30	300	Wells	0.04	---	---	---	---	---
Goree	LC11	700	Wells	0.09	200	Trib. of Brazos	1,412	1,184	---
Seymour	B832	4,500	Wells	0.45	3,000	Brazos R.	803	587	600

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
ELM CREEK	B786								
Throckmorton	EC26	1,300	Surf.	0.15	1,250	South Elm Cr.	---	---	255
New Castle	B781	750	Surf.	0.035	700	Brazos River	---	---	248
Subarea 2C									
CLEAR FORK	B760								
BUFFALO CREEK	CF225								
Hermleigh	BC21	400	Wells	0.05	---	---	---	---	649
Rotan	CF216	3,200	Wells	0.35	2,000	Lagoon & land irr.	2,005	347	330
SWEETWATER CREEK	CF184								
Roscoe	SW41	1,700	Wells	0.175	1,000	Lagoon & land irr.	436	---	---
Sweetwater	SW30	17,000	Surf.	2.2	10,000	Land irr.	---	---	264
BITTER CREEK	CF164								
Merkel	BC19	---	Abilene	---	1,500	Lagoons & land irr.	---	---	848
ELM CREEK	CF141								

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
CEDAR CREEK	EC15								
Abilene	CC7	71,000	Surf.	9.45	72,000	Land irr.	---	---	382
Subarea 2D									
DEADMAN CREEK	CF129								
Clyde	DM32	925	Wells	0.09	1,100	Kayser Creek	1,085	650	---
CALIFORNIA CREEK	CF80								
Hamlin	CC73	3,800	Surf.	0.50	2,400	Calif. Creek	---	---	243
TRIB. OF CALIFORNIA CR.	CC49								
Anson	T14	3,000	Surf.& wells	0.30	2,500	Lagoons	3,484	230	228
OTEYS CREEK	CC17								
Stamford	OC22	6,000	Surf.	0.65	5,000	Clear Fork & Brazos	---	---	208
PAINT CREEK	CC15								

Table B-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
TRIB. OF CALIFORNIA CR.	CC12								
Haskell	T20	4,500	Wells	0.97	2,500	Trib. to Brazos	---	---	1,308
HUBBARD CREEK	CF25								
Baird	HC60	2,160	Surf.	1.9	1,300	Land irr.	---	---	162
DEEP CREEK	HC31								
Putman	DC29	300	Wells	0.02	---	---	---	---	---
Moran	DC12	600	Surf.	0.04	350	Post Oak Cr.	---	---	---
GONZALES CREEK	HC2								
Breckenridge	GC11	6,500	Surf.	0.40	6,000	Gonzales Ri.	---	---	230
Eliasville	CF10	140	Surf.	0.008	---	---	---	---	---
Subarea 2F									
SALT CREEK	B743								
Olney	SC27	4,200	Surf.	0.53	4,000	Land irr.	---	---	328
Jean	SC22	150	Well	0.015	---	---	---	---	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
TRIBUTARY OF SALT CREEK	SC15								
Loving	T11	300	Well	---	---	---	---	---	585
Graham	SC4	8,500	Surf.	1.08	6,000	Land irr.	---	---	250
ROCK CREEK	B72.3								
Bryson	RC16	450	Wells	0.03	450	Carmicheal Cr.	---	---	633
BIG CADDO CREEK	B70.6								
Caddo Mills	BC17	820	Caddo Cr.	0.035	250	West Caddo Fork	---	---	352
KEECHI CREEK	B658								
Graford	K8	700	Keechi Cr.	0.05	---	---	---	---	---
TRIB. OF KEECHI CREEK									
Perrin	T13	370	Wells	0.018	---	---	---	---	---
Mineral Wells	B644	10,000	Wells Surf. Brazos	3.0	9,500	Brazos Ri.	---	---	320

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
PALO PINTO CREEK	B614								
Strawn	PPC35	1,000	Surf.	0.09	---	---	---	---	205
Mingus	PPC29	500	Surf.	0.03	---	---	---	---	---
Gordan	PPC26	400	Surf.	---	---	---	---	---	---
KICKAPOO CREEK	B584								
Lipan	K13	320	Wells	0.02	---	---	345	---	---
Granbury	B558	3,200	Wells	0.27	1,000	Lambert Br. to Brazos Ri.	597	510	---
Subarea 3C									
PALUXY CREEK	B506								
Glen Rose	Pa6	1,255	Wells	0.11	750	Paluxy Cr.	429	---	---
NOLANDS RIVER	B472								
Godley	NR37	435	Wells	0.035	---	---	408	---	---
Cleburne	NR27	18,840	Wells	1.79	11,500	Buffalo Cr.	640	554	---
Rio Vista	NR18	367	Wells	0.02	---	---	---	---	---
Blum	NR8	405	Wells	0.036	---	---	572	---	---

Table B-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Kopperl	B470	185	Wells	0.04	---	---	---	---	---
TRIBUTARY OF BRAZOS	B463								
Walnut Springs	T25	875	Wells	0.07	----	---	512	378	---
Morgan	T14	435	Wells	0.02	---	---	---	---	---
China Springs	B417	320	Wells	0.04	---	---	---	---	---
AQUILLA CREEK	B416								
Covington	Aq46	200	Wells	0.018	---	---	---	---	---
Whitney	Aq26	1,300	Wells	0.09	825	Wash Cr. to Whitney Res.	---	---	---
TRIB. OF AQUILLA CREEK	Aq21								
Itasca	T23	1,800	Wells	0.16	1,500	Hackberry Cr.	830	608	785
Hillsboro	T11	8,000	Wells	0.50	8,500	Hackberry Cr.	---	---	---
Aquilla	Aq16	180	Flowing Well	0.05	---	---	---	---	2,215

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
Subarea 3B									
BOSQUE RIVER	B410								
NORTH BOSQUE RIVER	BO6								
Stephenville	NBO108	9,000	Wells	0.75	7,000	Bosque Ri. land irr.	---	---	464
Hico	NBO83	1,600	Wells	0.110	1,200	Jacks Branch	403	402	414
Meridian	NBO52	1,100	Wells	0.09	500	Bosque Ri.	---	---	467
NEIL CREEK	NBO31								
Cranfills Gap	NC25	590	Wells	0.04	---	---	---	---	398
Valley Mills	NBO27	1,035	Wells	0.09	1,000	Bosque Ri.	585	---	---
SOUTH BOSQUE RIVER	BO6								
McGregor	SBO21	4,800	Wells	0.21	3,000	Trib. to Bosque R.	730	722	---
MIDDLE BOSQUE	SBO9								
Crawford	MBO13	500	Well	0.035	---	---	---	---	558

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
Subarea 3G									
Waco	B404	116,000	Brazos lake	14.0	100,000	Brazos Ri.	---	---	260
TEHUACAN CREEK	B394								
West	T30	2,200	Wells	0.15	1,900	Trib. to Brazos	---	---	650
Leroy	T22	490	Wells	0.023	---	---	---	---	---
Elm Mott	T17	950	Well	0.025	500	Cr. to Brazos	---	---	---
CASTLEMAN CREEK	B387								
Hewitt	CC16	175	Well	0.003	---	---	---	---	---
COW BAYOU	B370								
Moody	C36	1,200	Wells	0.08	900	Cow Bayou	---	---	900
Brueeville	C18	345	Well	0.012	---	---	---	---	---
FOSTER BRANCH	C11								
Lorena	F8	575	Well	0.03	---	---	---	---	875

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
DEER CREEK	B367								
Eddy	DC28	650	Well	0.03	---	---	---	---	---
Chilton	DC7	550	Art. Well	0.025	---	---	2,060	---	---
TRIBUTARY OF BRAZOS	B364								
Marlin	T6	8,000	Surf.	0.70	5,200	Brazos Ri.	---	---	205
TRIBUTARY OF BRAZOS	B348								
Lott	T18	950	Flow Well	0.30	500	Pool Creek	---	---	---
POND CREEK	B336								
Rosebud	PC20	1,600	Surf.	0.10	1,500	Pond Creek	5,505	732	---
Subarea 3A									
LITTLE RIVER	B315								
LEON RIVER	Li102								
SOUTH FORK	Le299								

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
Cisco	SF19	5,500	Lake & Sandy Cr.	0.70	5,000	Sandy Cr.	---	---	180
Eastland	Le299	4,200	Lake Leon	0.55	4,800	Leon Ri.	1,710	140	---
COLONY CREEK	Le285								
Ranger	CoC10	4,000	Lake Leon	0.55	4,000	Palo Pinto Cr.	---	---	175
SABANA RIVER	Le248								
Gorman	Sa20	1,200	Wells	---	1,250	Trib. to Leon	1,971	567	925
DeLeon	Sa9	2,200	Wells	0.17	2,700	Leon River	---	---	642
COPPERAS CREEK	Le239								
Rising Star	CoC38	1,500	Wells	0.12	1,200	Leon River	---	---	589
INDIAN CREEK	Le225								
Comanche	IC15	3,600	Surf.	0.30	1,600	Land irr	---	---	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Source	Use mgd	Waste Disposal Population Served 1957	Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
RESLEY CREEK	Le193								
Dublin	Re27	2,900	Deep Wells	0.30	2,800	Resley Creek	390	353	375
TRIB. OF LEON RIVER	Le174								
Hamilton	T10	3,000	Wells Surf.	0.25	4,500	Pecan Cr. to Brazos	888	813	855
Gatesville	Le104	5,000	Wells	0.43	5,000	Leon River	1,215	1,182	1,200
Oglesby	Le67	500	Wells	0.035	---	---	---	---	---
COWHOUSE CREEK	Le21								
Pottsville	CoC90	450	Wells	---	---	---	---	---	---
Evant	CoC63	475	Wells	0.02	---	---	---	---	---
HOUSE CREEK	CoC25								
Copperus Cove	HC12	4,200	Lake Belton	---	---	House Cr.	3,055	2,281	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
SOUTH NOLAN CREEK	Le8								
Killeen	SNC26	26,500	Lake Belton	---	20,000	Nolan Creek	---	---	325
Nolanville	SNC16	WCID #3 Bell Co.	Lake Belton	---	---	---	---	---	---
Belton	Le8	6,500	3 Wells	0.80	5,000	Nolan Creek	1,395	1,376	---
TRIBUTARY OF LEON RIVER	Le7								
Temple	T9	33,912	Wells River Surf.	3.77	20,000	Knob Creek	1,050 (wells)	261 (surf)	
Subarea 3D									
LAMPASAS RIVER	Li102								
SULPHUR CREEK	La78								
Lampasas	SC12	5,750	Sulphur Cr.	0.834	4,500	Sulphur Cr.	---	---	763
SALADO CREEK	La1								
Florence	SC39	550	Wells	0.05	---	---	---	---	---
Jarrell	SC25	335	Wells	0.02	---	---	---	---	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Little River	Li98	245	Well	0.02	---	---	---	---	---
DARRS CREEK	Li77								
Holland	DC12	690	Well	0.05	700	Darrs Creek	---	---	2,413
DONAHOE CREEK	Li62								
Bartlett	Do19	1,750	Wells	0.200	1,500	Little Creek	1,690	1,646	1,710
Subarea 3E									
SAN GABRIEL RIVER	Li44								
SOUTH FORK	SG57								
Liberty Hill	SF22	445	Wells	0.02	---	---	---	---	---
Georgetown	SF1	5,000	Wells	0.72	3,500	Land irr.	492	395	244
BRUSHY CREEK	SG6								
Round Rock	BC47	1,600	Wells	0.10	200	Trib. to Brazos	---	---	384
Hutto	BC37	535	Well	0.03	---	---	---	---	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
TRIB. OF BRUSHY CREEK	BC27								
Taylor	T9	9,500	Art. Well	0.75	7,500	Dry Cr. to Brazos	1,321	1,294	1,420
Thorndale	BC16	1,300	Surf.	0.05	---	Brushy Creek	---	---	234
Subarea 3D									
Cameron	Li32.5	8,500	Little River	0.504	6,000	Little River	---	---	382
ELM CREEK	Li27								
Troy	EC46	250	Well	0.025	---	---	---	---	---
SOUTH ELM CREEK	EC13								
Rogers	SE10	950	Wells	0.08	---	---	1,130	1,088	---
NORTH ELM CREEK	EC7								
Subarea 3G									
LITTLE BRAZOS RIVER	B286								
Reagan	LB60	120	Well	0.015	---	---	---	---	---

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	System ppm
Culvert	LB35	2,300	Wells	0.142	1,100	Town Br.	784	740	745
Hearne	LB23	6,000	Wells	0.704	5,000	Brazos Ri.	540	452	---
Subarea 3F									
YEGUA CREEK	B248								
FIRST YEGUA CREEK	YC42								
Rockdale	FYC78	6,700	Wells	0.574	2,000	Brazos Ri.	400	185	506
MIDDLE YEGUA CREEK	YC42								
Lexington	MYC19	1,000	Wells	0.126	---	---	1,340	275	280
Dime Box	MYC8	300	Well	0.005	---	---	---	---	---
Somerville	YC20	1,575	Wells	0.20	1,100	Cr. to Brazos	1,777	1,772	---
DAVIDSON CREEK	YC13								
Caldwell	DC22	3,200	Flow. Deep Well	0.226	1,500	Davidson Cr.	405	107	400

Table B-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
Subarea 3H									
NAVASOTA RIVER	B233								
Mount Calm	Na155	400	Surf.	0.30	200	Navasota Ri.	---	---	---
Mexia	Na138	7,800	Wells Spr.	0.50	5,500	Plumbers Cr.	498	335	740
CHRISTMAS CREEK	Na138								
Prairie Hill	CC13	300	Res.	0.02	---	---	---	---	---
Groesback	Na125	2,300	Surf. Nav. Ri.	0.18	1,300	Liberty Br. to Navasota Ri.	220	---	190
STEELE CREEK	Na107								
Thornton	SC25	620	Wells	0.45	300	Land irr.	---	---	---
CARTERS CREEK	Na34								
Bryan	Ca13	22,000	Wells	3.308	16,500	Cr. & Brazos R.	244	191	190
Navasota	Na7	6,000	Wells	0.78	4,500	Navasota Ri.	678	615	---

Table B-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 4A									
NEW YEAR CREEK	B197								
Brenham	NYC15	10,000	Wells	0.677	6,250	Branch	525	370	203
TRIBUTARY OF BRAZOS RIVER	B188								
Hempstead	T4	2,200	Wells	0.145	4,800	Brazos Ri. Shawne Cr. to Angelina Cr.	425	410	425
MILL CREEK	B160								
Bellville	MC11	2,300	Wells	0.35	2,100	Boggy Creek	544	482	520
Sealy	B150	2,500	Deep Wells	0.173	1,200	Ballinger Cr.	230	125	193
TRIBUTARY OF BRAZOS RIVER	B122								
Brookshire	T10	1,100	Wells	0.051	---	Brazos River	---	---	320
Rosenburg	B100	10,000	Wells	0.782	1,000	Land irr.	552	330	330
IRRIGATION CANAL	B95								

Table B-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Richmond	B93	3,210	Wells	0.321	1,500	Brazos Ri.	349	300	---
Sugarland	B86	2,200	Wells	0.619	1,500	Oyster Cr.	380	330	383
TRIBUTARY OF BRAZOS RIVER	B31								
Damon	T14	500	Well	0.04	---	---	---	----	---
Brazoria	B22	1,600	Wells	0.21	1,000	Irr. ditch to Brazos	---	---	985
Freeport	B4	15,000	Wells	1.25	1,500	Brazos Ri.	947	874	250

TABLE B-4

SALINE GROUND WATERS IN THE BRAZOS RIVER BASIN

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1A - White River	Tr13	Floyd	863	7,320	13,700	Dockum Group	N	68	White River
1B - Double Mountain Fork (upper portion)	Tr21	Lubbock	1,850	10,800	20,600	Dockum Group	---	---	Double Mountain
	O-20	Hockley	360	166	1,080	Ogallala Formation	P	---	Double Mountain
	21	Lubbock	398	151	1,080	Ogallala Formation	P	---	Double Mountain
	22	Lubbock	421	146	1,080	Ogallala Formation	P	---	Double Mountain
	23	Lamb	1,670	732	3,810	Ogallala Formation	Irr.	---	Double Mountain
	24	Lamb	1,780	748	4,030	Ogallala Formation	Irr.	---	Double Mountain
	25	Lamb	3,020	1,310	6,450	Ogallala Formation	S	---	Double Mountain
2A - Salt Fork Brazos	P32	Stonewall	2,310	560	4,250	San Angelo Sandstone	S	---	Tank Cr.

*D, domestic; S, stock; Ind, industrial; Irr, irrigation; P, public supply; N, none.

Table B-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2A (Continued)	33	Stonewall	5,890	1,270	71,000	San Angelo Sandstone	S	---	Tank Cr.
	41	Stonewall	1,620	1,410	4,520	Blaine Gypsum	---	77	Salt Fork
	75	Stonewall	1,590	4,730	10,000	Quartermaster F.	---	75	Salt Fork
	76	Stonewall	1,800	23,300	40,300	Quartermaster F.	---	75	Salt Fork
	77	Dickens	1,200	552	71,000	Quartermaster F.	---	63	Croton Cr.
2B - Double Mountain Fork (lower portion)	P16	Jones	736	725	2,460	Wichita & Clear Fork	D	---	California Creek
	17	Jones	1,060	138	1,940	Wichita & Clear Fork	D, S	---	California Creek
	18	Jones	1,310	228	2,370	Wichita & Clear Fork	Ind	69	California Creek
	19	Jones	3,070	1,300	6,590	Wichita & Clear Fork	D, S	---	California Creek
	20	Jones	882	208	1,670	Wichita & Clear Fork	---	---	California Creek
	21	Jones	1,060	138	1,940	Wichita & Clear Fork	---	---	California Creek

Table B-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2B (Continued)	29	Jones	2,860	372	4,790	San Angelo Sandstone	---	---	California Creek
	30	Jones	1,740	1,870	8,020	San Angelo Sandstone	D, S	---	Clear Fork
	31	Jones	1,430	285	2,730	San Angelo Sandstone	D, S	---	Clear Fork
	39	Jones	2,180	139	3,380	Blaine Gypsum	S	70.5	California Creek
	P15	Jones	1,590	391	3,450	Wichita & Clear Fork	P	---	California Creek
2C - Clear Fork Brazos (upper portion)	P40	Fisher	2,310	268	3,740	Blaine Gypsum	S	---	Clear Fork
	P13	Taylor	545	56	1,130	Wichita & Clear Fork	P	---	Clear Fork
	14	Taylor	1,410	161	2,610	Wichita & Clear Fork	P	---	Clear Fork
	73	Fisher	950	122	1,760	Quartermaster Formation	D, S	---	Clear Fork
	74	Fisher	1,780	1,220	4,520	Quartermaster Formation	S	---	Clear Fork

Table B-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2D - Clear Fork Brazos (lower portion)	R13	Jones	286	320	1,240	Alluvium	D, S	69.5	California Creek
	15	Haskell	386	296	1,410	Alluvium	P	---	Paint Cr.
2E - Brazos River mile 899 to mile 756	P22	Knox	1,750	395	71,000	Wichita & Clear Fork	---	---	Brazos R.
	23	Baylor	524	640	2,430	Wichita & Clear Fork	---	---	Brazos R.
	24	Baylor	---	2,000	71,000	Wichita & Clear Fork	---	---	Brazos R.
	R14	Haskell	286	320	1,240	Alluvium	Irr	---	Brazos R.
	16	Knox	251	365	1,490	Alluvium	P	---	Brazos R.
	R17	Knox	469	340	1,850	Alluvium	P	---	Brazos R.
	18	Knox	315	251	1,140	Alluvium	P	---	Brazos R.
	19	Baylor	207	75	1,140	Alluvium	---	---	Brazos R.
2F - Brazos River mile 756 to mile 508	C5	Palo Pinto	2,310	260	4,200	Penn. undifferentiated	P	71	Brazos R.

Table B-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
3A - Leon River	C13	Eastland	2.5	922	1,950	Penn. undifferentiated	---	---	Leon River
	K59	Coryell	700	530	2,280	Trinity Group	P	---	Cowhouse Creek
	60	Coryell	233	286	1,220	Trinity Group	P	77	Leon River
	61	Coryell	334	246	1,280	Trinity Group	P	72	Cowhouse Creek
	62	Coryell	1,470	180	2,940	Trinity Group	D, S	---	Leon River
	63	Coryell	798	295	2,020	Trinity Group	---	---	Leon River
3B - Bosque River	K31	Bosque	1,760	158	3,390	Paluxy Sand	---	---	Bosque R.
	58	Bell	840	190	1,830	Trinity Group	---	---	Nolan Creek
	65	McLennan	2,330	180	4,300	Trinity Group	---	---	Bosque R.
	66	McLennan	1,830	242	3,330	Trinity Group	P	114	Brazos R.
	94	McLennan	1,770	760	4,100	Woodbine Sand	---	---	Brazos R.
	95	McLennan	2,270	198	3,800	Woodbine Sand	---	---	Brazos R.

Table B-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
3C - Brazos River mile 508 to mile 406	K32	Hill	796	105	1,850	Paluxy Sand	P	---	Aquillo Creek
	67	Hill	1,090	73	2,160	Trinity Group	P	---	Aquillo Creek
	69	Hill	683	40	1,400	Trinity Group	P	---	Aquillo Creek
	99	Hill	681	182	1,830	Woodbine Sand	S, Irr	---	Aquillo Creek
3D - Lampasas and Little Rivers	C8	Lampasas	129	51,200	83,600	Penn. undifferentiated	---	---	Lampasas River
	K6	Lampasas	407	350	1,470	Travis Peak	---	---	Lampasas River
	7	Bell	951	1,010	3,620	Travis Peak	---	---	Lampasas River
	8	Bell	269	248	1,200	Travis Peak	---	---	Lampasas River
	27	Bell	527	205	1,440	Glen Rose limestone	D, S	---	Nolan Cr.
	28	Bell	250	246	71,000	Glen Rose limestone	P	---	Leon River

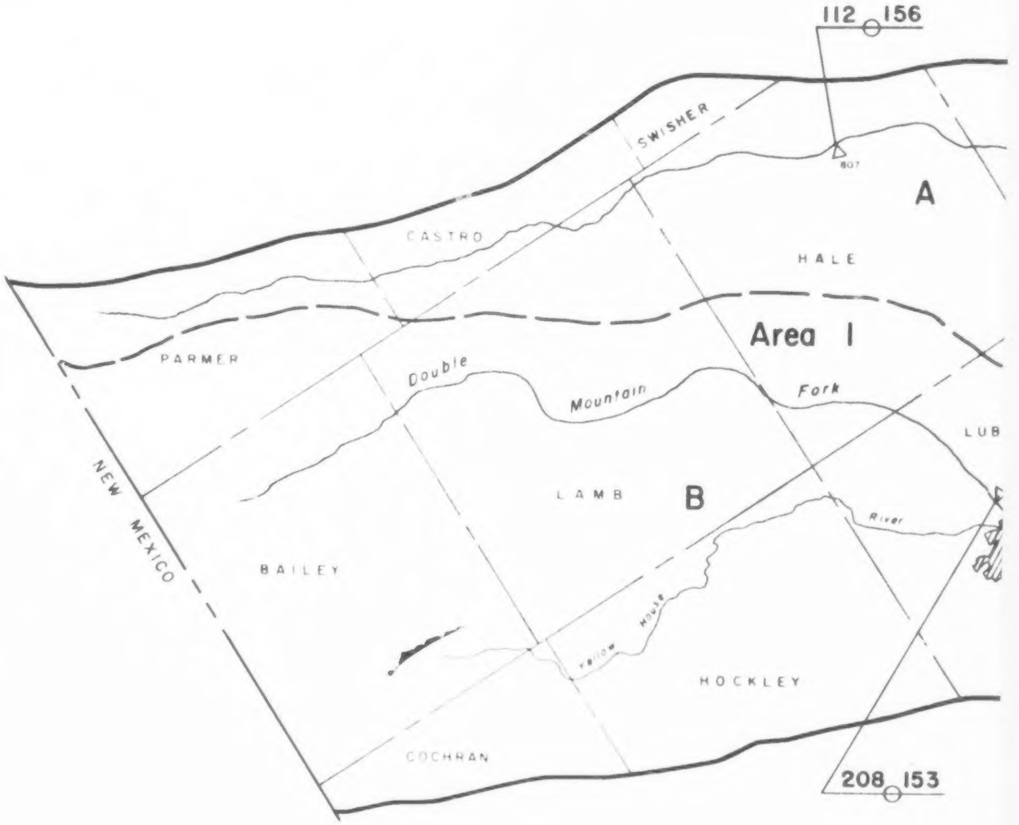
Table B-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
3D (Continued)	56	Bell	978	362	2,400	Trinity Group	P	---	Dorris Cr.
	57	Bell	376	275	1,450	Trinity Group	P	---	Lampasas River
3E - San Gabriel River	K54	Williamson	542	360	1,810	Trinity Group	P	---	Donahue Creek
	55	Williamson	421	182	1,330	Trinity Group	P	115	San Gabriel
	88	Williamson	384	308	1,520	Edwards limestone	P	---	Brushy Creek
3F - Yegua Creek	E42	Lee	155	94	1,080	Carrizo Sand	P	94.5	Nails Cr.
	51	Burleson	1	144	1,530	Queen City Sand	---	---	Davidson Creek
	62	Burleson	244	151	1,030	Sparta Sand	D	---	Davidson Creek
	E63	Burleson	98	570	1,720	Sparta Sand	---	---	Davidson Creek
	71	Burleson	222	585	1,810	Claiborne Group	P	---	Davidson Creek
	72	Burleson	284	420	1,470	Claiborne Group	D, S	---	Davidson Creek

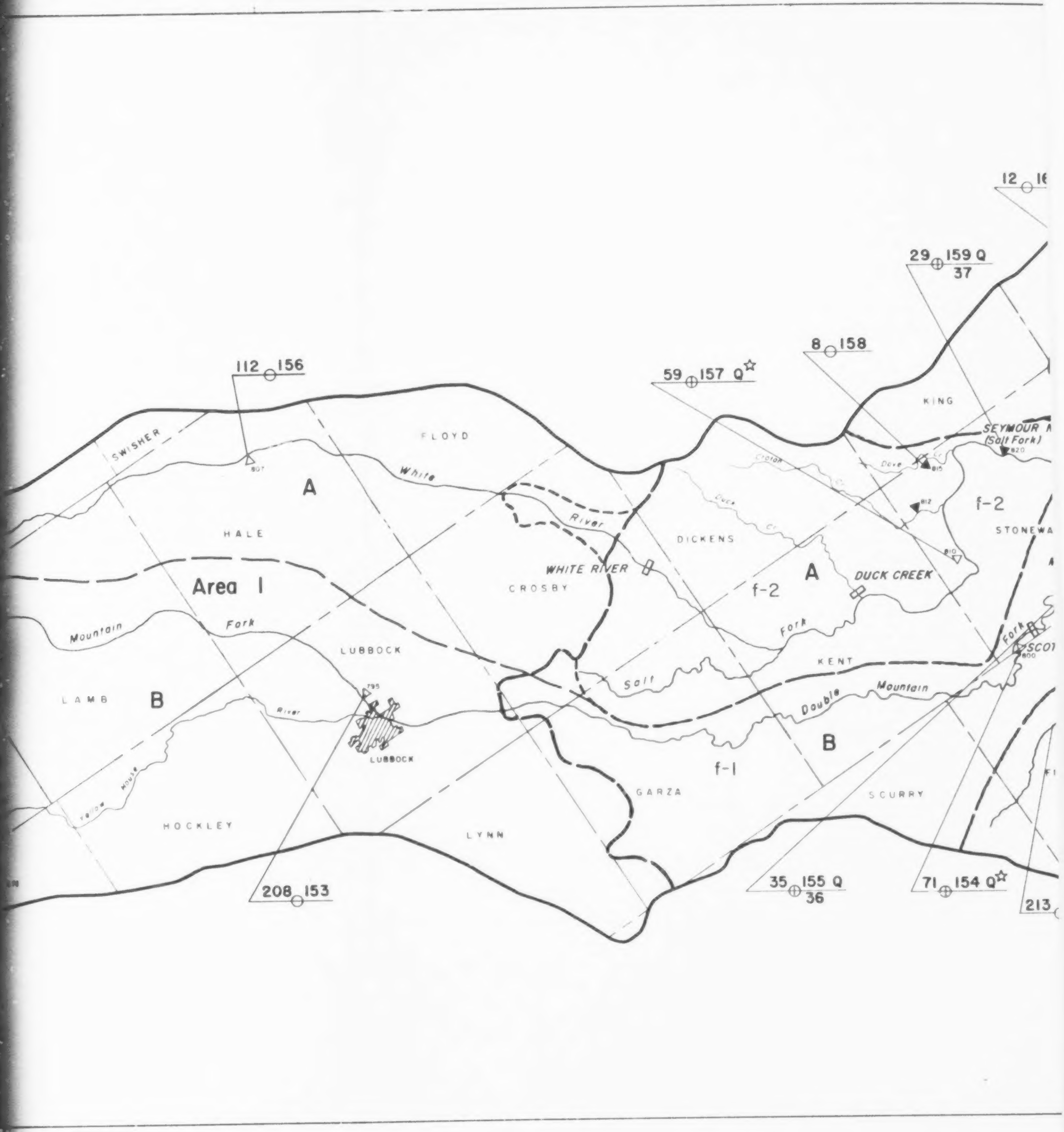
Table B-4 (Continued)

Area	Well No.	County	SO4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
3G - Brazos River, mile 406 to 232	K9	Falls	749	83	1,560	Travis Peak	P	138	Brazos R.
	29	Falls	4,470	645	8,020	Glen Rose limestone	---	134	Brazos R.
	64	Falls	802	66	1,680	Trinity Group	D, S, P	112	Brazos R.
	E9	Brazos	11	50	1,080	Wilcox Group	S	---	Brazos R.
	52	Brazos	4.1	502	1,650	Queen City Sand	---	---	Brazos R.
3H - Navasota River	---	---	---	---	---	---	---	---	---
4A - Brazos River, mile 232 to mouth	---	---	---	---	---	---	---	---	---
4B - Adjoining area	0-56	Brazoria	2	1,350	2,480	Goliad Sand,etc.	D, S	---	Oyster Cr.
	57	Galveston	1	1,060	2,020	Goliad Sand,etc.	N	---	To Bay
	B11	Brazoria	2	1,620	2,820	Beaumont Clay	D, S	---	Brazos R.
	12	Brazoria	25	410	1,340	Beaumont Clay	Irr	---	To Bay
	13	Galveston	2.9	875	1,780	Beaumont Clay	---	---	To Bay
	14	Galveston	2	820	1,660	Beaumont Clay	P	---	To Bay
	15	Galveston	0.0	3,400	5,870	Beaumont Clay	---	---	To Bay
	16	Galveston	---	351	1,070	Beaumont Clay	D, S	---	To Bay
	17	Galveston	57	1,160	2,430	Beaumont Clay	---	---	To Bay

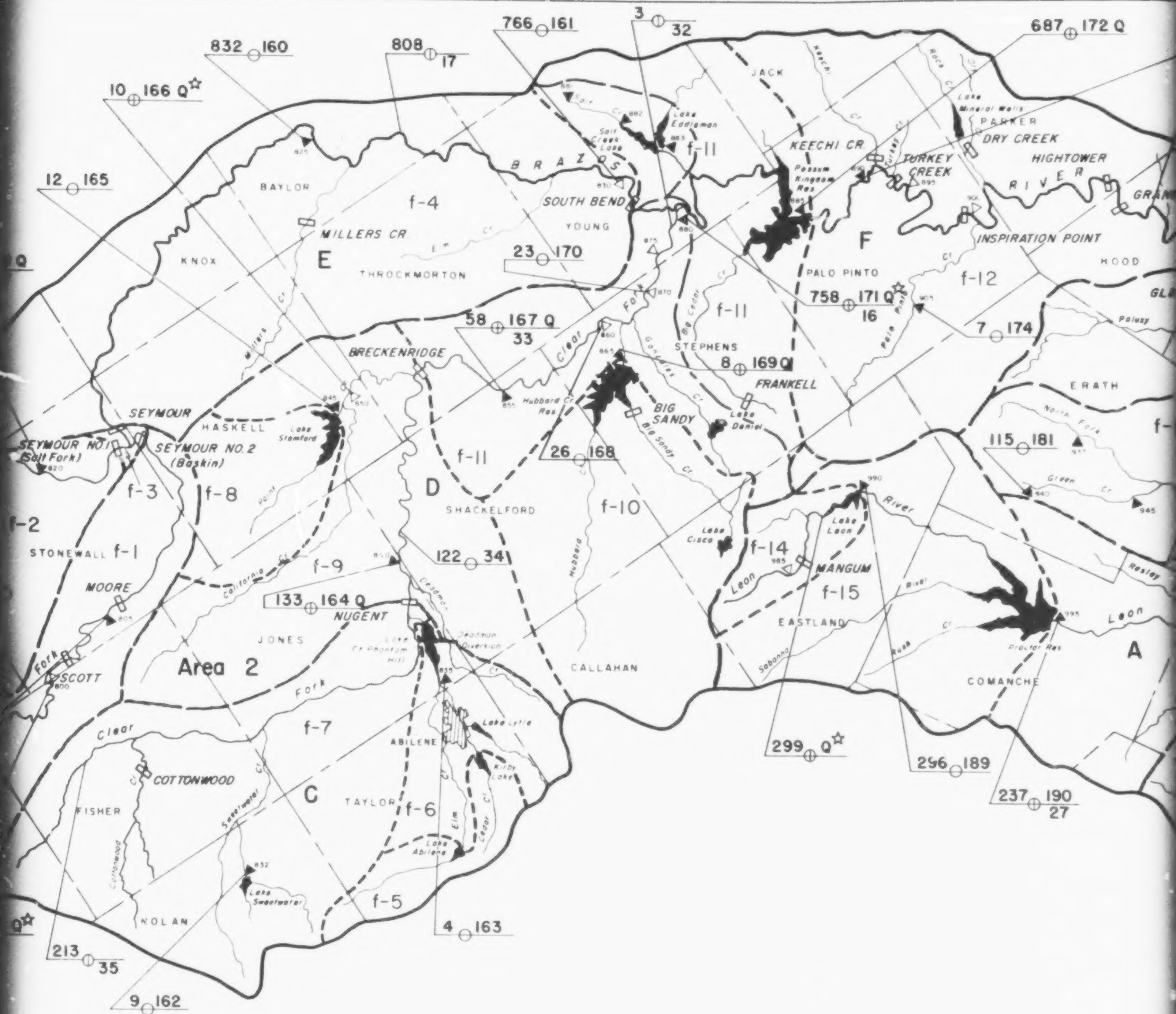
A


112
156
SWISHER
807
A
CASTRO
HALE
Area I
PARMER
Double Mountain Fork
LUB
NEW MEXICO
LAMB
B
BAILEY
River
Yellow House
HOCKLEY
COCHRAN
208
153

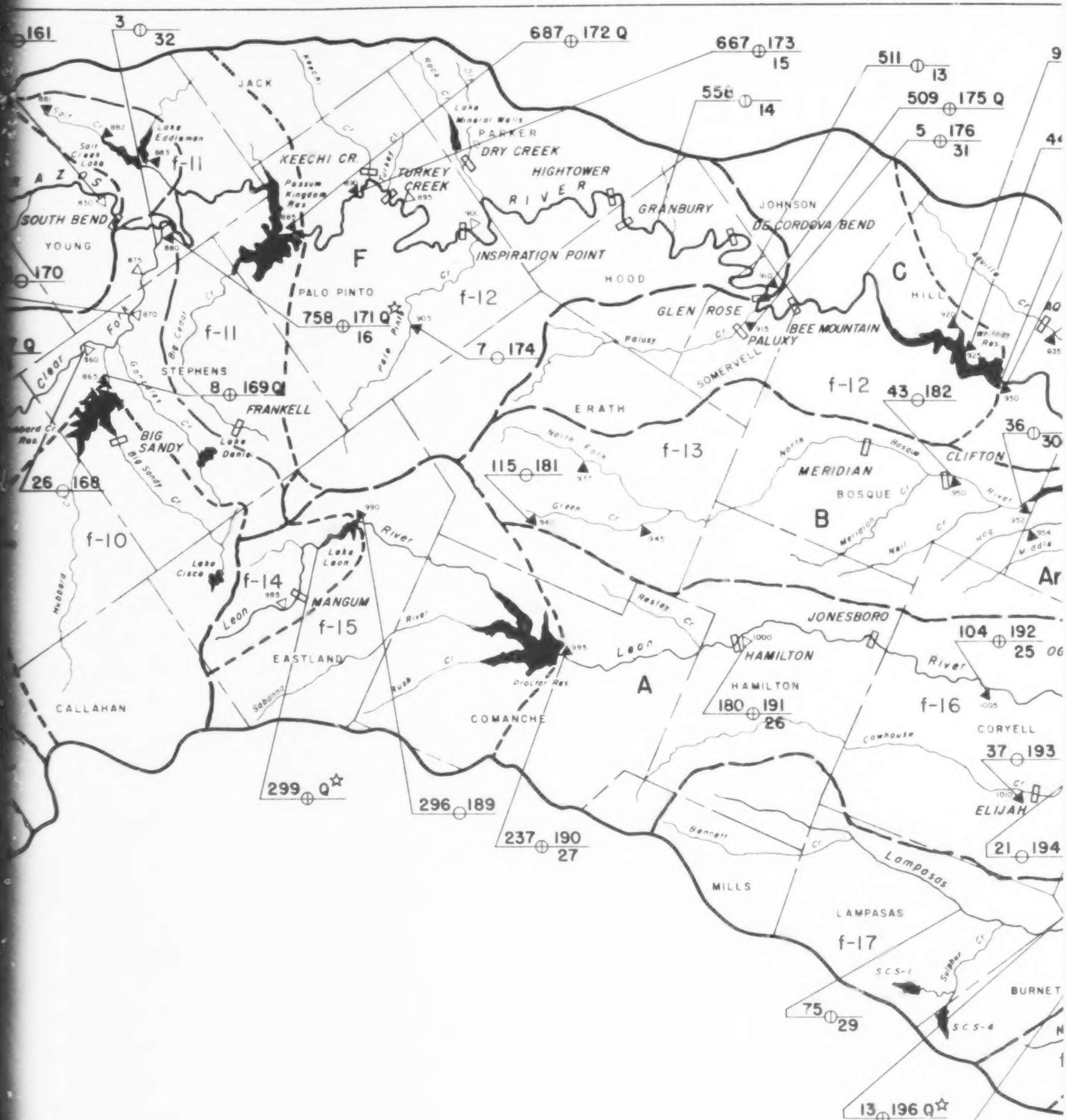
B


12 16
29 159 Q
37
8 158
59 157 Q☆
112 156
SWISHER
FLOYD
KING
SEYMOUR
(Salt Fork)
820
807
A
White
River
HALE
Croton
Duck
Cr.
Dove
815
812
f-2
STONEWA
DICKENS
WHITE RIVER
A
DUCK CREEK
810
Area I
CROSBY
f-2
Mountain
Fork
LUBBOCK
Fork
KENT
Fork
SCOT
800
795
Salt
LAMB
B
River
Double
Mountain
Yellow House
LUBBOCK
B
f-1
GARZA
SCURRY
HOCKLEY
LYNN
208 153
35 155 Q
36
71 154 Q☆
213

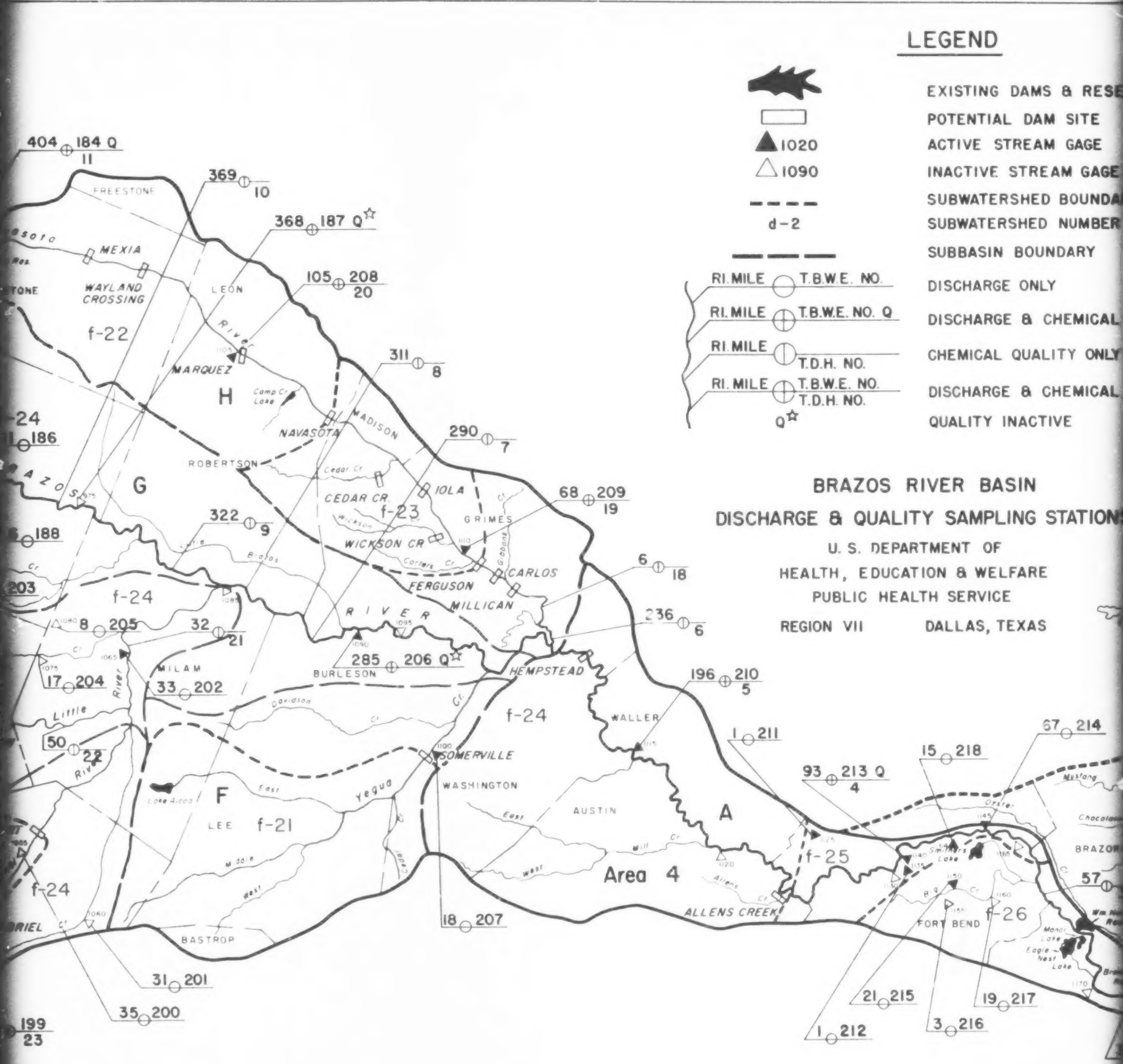
C



766 161
3 32
808 17
832 160
687 172 Q
10 166 Q☆
12 165
JACK
Lake Eddleman
Salt Creek Lake
Lake Mineral Wells
PARKER
DRY CREEK
KEECHI CR.
TURKEY CREEK
HIGHTOWER
BRAZOS
RIVER
f-11
Possum Kingdom Res
BAYLOR
f-4
SOUTH BEND
YOUNG
MILLERS CR.
E
F
INSPIRATION POINT
KNOX
THROCKMORTON
23 170
HOOD
PALO PINTO
f-12
758 171 Q☆
16
f-11
58 167 Q
33
7 174
Clear Fork
STEPHENS
BRECKENRIDGE
8 169 Q
FRANKELL
ERATH
North Fork
Hubbard Cr Res
SEYMOUR
HASKELL
Lake Stamford
BIG SANDY
Lake Daniel
115 181
SEYMOUR NO.1 (Salt Fork)
SEYMOUR NO.2 (Baskin)
f-11
26 168
Green Cr
f-3
f-8
D
f-2
SHACKELFORD
f-10
River
STONEWALL
f-1
Lake Leon
Lake Cisco
f-14
MANGUM
f-9
California Cr
122 34
Leon
f-15
MOORE
133 164 Q
NUGENT
Deadman Diversion
Lake Ft Phantom Hill
JONES
EASTLAND
Sabanna Cr
Rush Cr
Leon
Proctor Res
A
Area 2
Fork
SCOTT
CALLAHAN
COMANCHE
f-7
Clear
Lake Lytle
ABILENE
299 Q☆
296 189
COTTONWOOD
Kirby Lake
C
TAYLOR
f-6
Elm Cr
Cedar Cr
237 190
27
FISHER
Sweetwater Cr
Cottonwood
Lake Abilene
Lake Sweetwater
f-5
NOLAN
4 163
213 35
9 162



161
3 32
687 172 Q
667 173 15
511 13
558 14
509 175 Q
5 176 31
JACK
PARKER
Lake Eddleman
Salt Creek Lake
BRAZOS
f-11
KEECHI CR.
Possum Kingdom Res
Lake Mineral Wells
DRY CREEK
TURKEY CREEK
HIGHTOWER
RIVER
GRANBURY
JOHNSON
DE CORDOVA BEND
SOUTH BEND
YOUNG
170
F
INSPIRATION POINT
HOOD
C
HILL
PALO PINTO
f-12
GLEN ROSE
BEE MOUNTAIN
PALUXY
Whitney Res
Clear Fork
f-11
758 171 Q 16
7 174
STEPHENS
8 169 Q
FRANKELL
SOMERVELL
f-12
43 182
ERATH
36 30
Hubbard Cr Res
BIG SANDY
Lake Daniel
f-13
CLIFTON
26 168
115 181
MERIDIAN
BOSQUE
f-10
B
Lake Cisco
f-14
Lake Leon
MANGUM
Leon River
f-15
EASTLAND
Proctor Res
Leon
JONESBORO
104 192 25
HAMILTON
HAMILTON
180 191 26
A
CALLAHAN
COMANCHE
f-16
CORYELL
Cowhouse
37 193
ELIJAH
299 Q
296 189
237 190 27
21 194
Bennett Cr
Lampasos
MILLS
LAMPASAS
f-17
SCS-1
SCS-4
BURNET
75 29
13 196 Q
41 197


LEGEND
EXISTING DAMS & RESE
POTENTIAL DAM SITE
1020 ACTIVE STREAM GAGE
1090 INACTIVE STREAM GAGE
SUBWATERSHED BOUNDA
d-2 SUBWATERSHED NUMBER
SUBBASIN BOUNDARY
RI. MILE T.B.W.E. NO. DISCHARGE ONLY
RI. MILE T.B.W.E. NO. Q DISCHARGE & CHEMICAL
RI. MILE T.D.H. NO. CHEMICAL QUALITY ONLY
RI. MILE T.B.W.E. NO. T.D.H. NO. DISCHARGE & CHEMICAL
Q☆ QUALITY INACTIVE
404 184 Q 11
369 10
368 187 Q☆
105 208 20
311 8
290 7
68 209 19
6 18
236 6
196 210 5
322 9
32 21
8 205
17 204
33 202
285 206 Q☆
50 22
31 201
35 200
199 23
18 207
1 211
93 213 Q 4
15 218
67 214
57
21 215
1 212
3 216
19 217
186
188
203
FREESTONE
MEXIA
WAYLAND CROSSING
LEON
MARQUEZ
Camp Cr. Lake
NAVASOTA
MADISON
ROBERTSON
BRAZOS
Cedar Cr.
CEDAR CR.
IOLA
GRIMES
WICKSON CR
CARLOS
FERGUSON
MILLICAN
RIVER
BURLESON
HEMPSTEAD
MILAM
Little River
Davidson Cr.
SOMERVILLE
WASHINGTON
Lake Alcoa
LEE
Yegua
East
West
Middle
AUSTIN
WALLER
Mill Cr.
Allens Cr.
ALLENS CREEK
BASTROP
FORT BEND
Smithers Lake
Oyster
Mustang
Chocolate
BRAZOS
Manor Lake
Eagle Nest Lake
Big Cr.
f-22
f-23
f-24
f-21
f-25
f-26
H
G
F
A
Area 4
1105
1110
1115
1120
1125
1130
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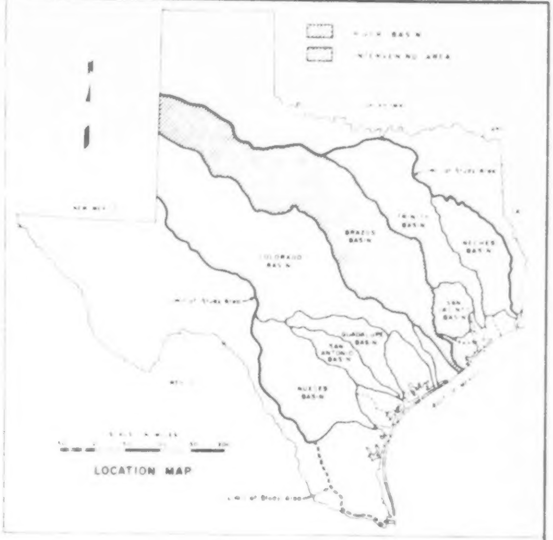
1165
1170
1075
1080
1085
1090
1095
1100
1060
1065
975

BRAZOS RIVER BASIN
DISCHARGE & QUALITY SAMPLING STATION
U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

80-A F

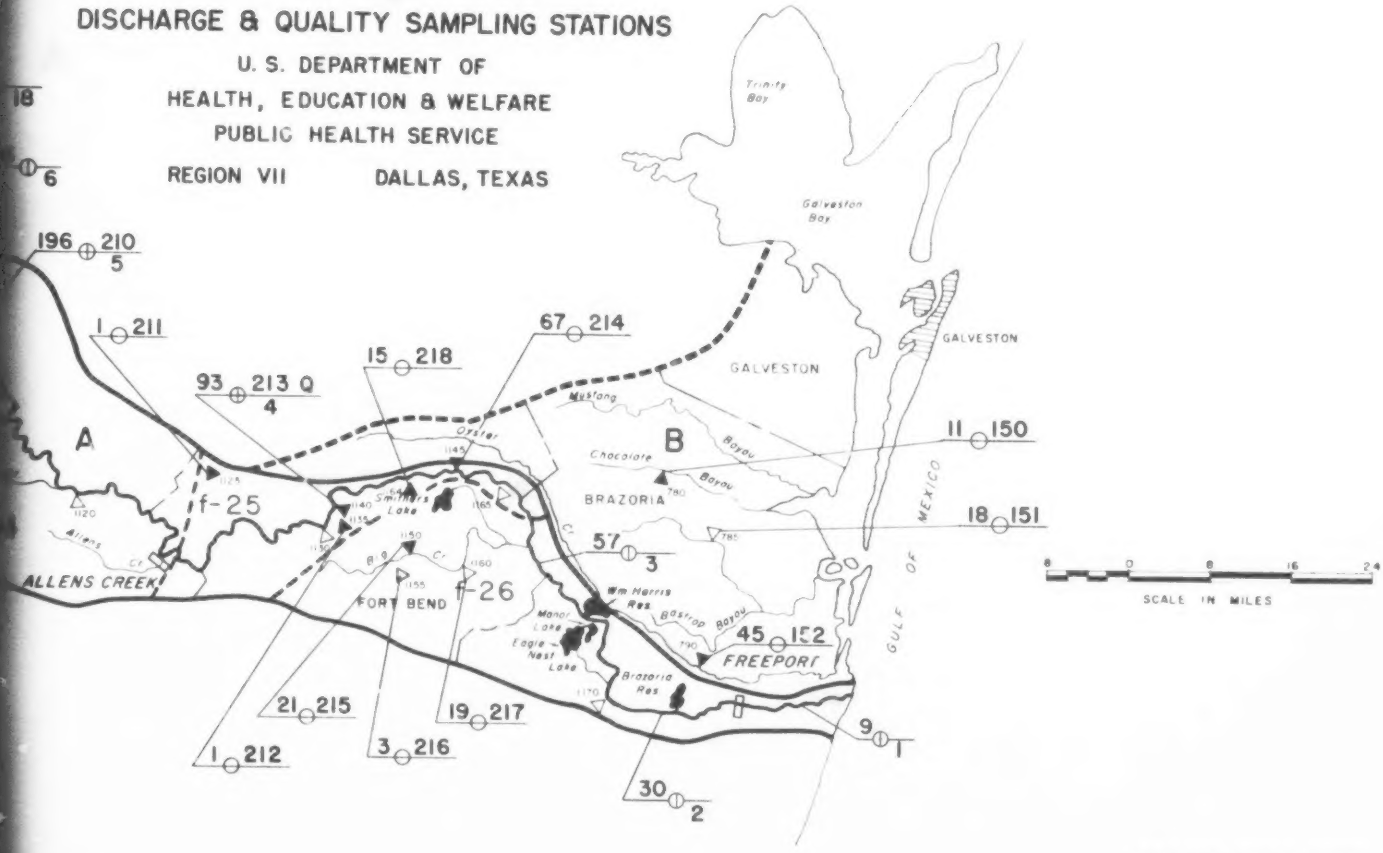
LEGEND

■	EXISTING DAMS & RESERVOIRS
▭	POTENTIAL DAM SITE
▲1020	ACTIVE STREAM GAGE
△1090	INACTIVE STREAM GAGE
- - - -	SUBWATERSHED BOUNDARY
d-2	SUBWATERSHED NUMBER
— — —	SUBBASIN BOUNDARY
RI. MILE ⊖ T.B.W.E. NO.	DISCHARGE ONLY
RI. MILE ⊕ T.B.W.E. NO. Q	DISCHARGE & CHEMICAL QUALITY (U.S.G.S.)
RI. MILE ⦶ T.D.H. NO.	CHEMICAL QUALITY ONLY
RI. MILE ⊕ T.B.W.E. NO. T.D.H. NO.	DISCHARGE & CHEMICAL QUALITY
Q☆	QUALITY INACTIVE


BRAZOS BASIN
COLORADO BASIN
TRINITY BASIN
NECHES BASIN
SAN JACINTO BASIN
GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
LOCATION MAP

BRAZOS RIVER BASIN
DISCHARGE & QUALITY SAMPLING STATIONS

U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS


18
6
Trinity Bay
Galveston Bay
196 210 5
1 211
93 213 Q 4
15 218
67 214
GALVESTON
GALVESTON
Mustang
Oyster
B
Chocolate
Bayou
Bayou
BRAZORIA
780
11 150
18 151
785
A
1120
1125
f-25
Allens Cr.
ALLENS CREEK
1140
1135
1130
Smithers Lake
1145
1165
1150
Big Cr.
1155
1160
FORT BEND
f-26
57 3
Cr.
Wm Harris Res.
Manor Lake
Eagle Nest Lake
Bastrop Bayou
790
45 152
FREEPORT
Brazoria Res.
1170
GULF OF MEXICO
21 215
19 217
1 212
3 216
9 1
30 2
SCALE IN MILES
8 0 8 16 24

BRAZOS RIVER BASIN

FIGURE NO. B-1

COLORADO RIVER BASIN

Present Quality of Water Resources in the Colorado River Basin

Section, or Subarea	Page
Physical Description	81
1A	82
2A	83
1B	84
2B	85
2E	86
2C	86
2D	87
2F	88
3B	89
3A	90
3C	90
3D	91
4	92
Statement of Texas Department of Health	95

Physical Description

Geography

The Colorado River rises in the border counties of western Texas and southeastern New Mexico. It flows about 900 miles in a south-southeasterly direction across the geographical center of Texas, draining an area of more than 42,500 square miles (40,100 square miles in Texas). The basin is bound by the Brazos River Basin on the northeast and by portions of the Rio Grande, Nueces, Guadalupe, and Lavaca Basins on the southwest. The basin is 100 to 150 miles wide in the upper and central parts and narrows to a corridor 10 to 15 miles wide along the lower 100 mile reach of the river.

Topography

In its course through Texas, the Colorado River passes through three major physiographic divisions; namely, the High Plains, the North Central Plains, and the Coastal Plains. About one-fourth of the basin, the upper 11,000 square miles, lies in the High Plains area, a high flat arid region of low annual rainfall, which contributes very little to the flow of the river. The central portion of the basin is in the rough and rocky Edwards Plateau, and the coastal section is flat, featureless prairie.

Rainfall-Runoff

Rainfall varies from about 19 inches at the eastern edge of the High Plains to about 45 inches at the mouth of the Colorado River. Average runoff for the entire basin was 1,747,000 acre-feet during the period 1940-1956, or 1.14 inches from the entire contributing drainage area.

Impoundments

As of June, 1958, there were sixteen major impoundments (over 5,000 acre-feet) and more than 34,000 minor reservoirs. Of the latter, 104 reservoirs were constructed by State agencies and local interests for various purposes, including municipal, industrial, irrigation, power, mining, and recreation.

Table C-1

COLORADO RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure C-1)

2A. Colorado River from mile 890 to mile 794.
    1A. Lost Draw and Sulphur Draw drain into dry lake.
    1B. Beals Creek joins Colorado River at mile 769.

2B. Colorado River from mile 794 to mile 665.

2E. Colorado River from mile 665 to mile 479.
    2C. Concho River joins the Colorado River at mile 628.
    2D. Pecan Bayou joins the Colorado River at mile 513.
    2F. San Saba River joins the Colorado River at mile 479.

3B. Colorado River from mile 479 to mile 300.
    3A. Llano River joins the Colorado River at mile 400.
    3C. Pedernales River joins the Colorado River at mile 354.

3D. Colorado River from mile 300 to mile 135.

4. Colorado River from mile 135 to mouth.

Present Quality of Surface and Ground Waters In Subareas of Colorado River Basin

Subarea 1A

Ground waters in Subarea 1A are obtained from the Ogallala formation. The city of Brownfield used 1,470 acre-feet of water from this formation during 1958. Brownfield's wells are from 107 to 132 feet deep. Samples collected in 1952 had the following quality:

Analysis	Concentration (ppm)
Total Solids	686-1,060
pH	7.5- 7.9
Alkalinity	225- 255
Silica	52- 81
Hardness	445- 630
Calcium	63- 96
Magnesium	67- 95
Sodium	35- 92
Iron	0.1- 6.8
Sulfate	143- 263
Chloride	99- 231
Fluoride	2.9- 3.5
Nitrate	4.9- 12.0

This analysis shows the water of Brownfield to be very hard and to contain excessive fluorides.

Subarea 1A is a noncontributing surface water area.

Subarea 2A

The Colorado River rises in this subarea at about mile 890, and drains an area of about 1,500 square miles, excluding Subarea 1B (Beals Creek), which joins the Colorado at mile 769. The boundary between Subarea 2A and 2B is at mile 794.

Quality records are available for stations at miles 845 and 834.5, for Beals Creek (Subarea 1B) which joins the Colorado at mile 769, Bull Creek which joins the Colorado at mile 832, Bluff Creek which joins the Colorado at mile 829, and Deep Creek (mile 814). Discharge records are available for stations at the Bull and Bluff Creek quality stations, the Colorado River at mile 825, and at mile 8 on Deep Creek.

The furthest upstream quality data for the Colorado River are at Lake Thomas (mile 845). A single sample collected on January 29, 1958, contained 269 ppm dissolved solids, 27 ppm chlorides, 55 ppm sulfates, and 108 ppm hardness. If this single analysis is representative of the water in Lake Thomas, then the quality is quite satisfactory for domestic and municipal water supply. The dam for the 204,000 acre-feet impoundment was constructed by the Colorado River Municipal Water District for municipal and industrial water supply for the cities of Big Spring, Odessa, and Snyder. It receives all the flow from Bull Creek.* Nearby oil fields used 7,770 acre-feet repressuring oil wells by the injection process.

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* From a diversion dam located some miles above the mouth (to avoid salt pollution).

Unregulated flow at mile 834 had high chlorides (maximum 118,900) possibly from oil field brine. The 1958 sample did not indicate any such pollution.

Bull and Bluff Creeks discharge about 15 cfs of water that ranges from very good to very poor chemical quality to the Colorado River.

Previous to regulation by Lake Thomas, the average discharge at mile 825 was 50.5 cfs.

Deep Creek discharged about 4.5 cfs to the Colorado (mile 814) during water year 1957-58; the average for 1953-58 has been 16.9 cfs. The average of constituents in Deep Creek during 1957-58 were:

Dissolved Solids	160 ppm
Chlorides	20 ppm
Sulfates	9.4 ppm

The discharge at mile 796 during water year 1957-58 averaged 23.6 cfs, containing 1,880 ppm dissolved solids (120 tons per day); 922 ppm chlorides (59 tons per day); 173 ppm sulfates (11 tons per day).

Besides the excessive chlorides and dissolved solids, the water was very hard, with 313 ppm hardness.

If Lake Thomas contains only 27 ppm chlorides, then an average of 70 cfs would be needed from that impoundment to reduce the chlorides from 922 ppm to 250 ppm at mile 796. With 80 per cent sodium, the water at this point would be of limited value for irrigation.

Ground waters in Subarea 2A are obtained from the alluvium and Dockum group. The city of Snyder obtains its water supply from surface water sources and used about 2,000 acre-feet during 1958.

Subarea 1B

This is the watershed of Beals Creek, which drains 7,730 square miles and joins the Colorado River at mile 769. Mineralization occurs from natural sources in the headwaters. The banks around the chain of lakes upstream from Big Spring are covered with a white salt deposit.

Only one chemical analysis and no discharge data have been located for this tributary. If this single sample represents the quality of water in Beals Creek, then it is a poor source for municipal and industrial water supply. Total dissolved solids were 1,800 ppm; chlorides, 640 ppm; sulfates, 356 ppm; and hardness, 452 ppm. These values all exceed the adopted criteria.

Ground waters in Subarea 1B are obtained from the Ogallala formation. The cities that draw from this formation include Andrews, Midland, and Odessa. Of these cities, the largest water user is Midland. Midland has drilled fourteen wells, the maximum depth of which is about 135 feet. Samples collected in 1952 and 1953 showed the following quality: total solids 820 to 2,208 ppm; total hardness from 48 to 1,036 ppm; chlorides from 124 to 731 ppm; sulfates from 133 to 771 ppm; fluorides from 2.8 to 7.5 ppm; nitrates from 7 to 25 ppm. This water is of poor quality from the standpoint of total solids, total hardness, chlorides, sulfates, fluorides, and occasionally nitrates.

Subarea 2B

The Colorado River passes from mile 794 to mile 665, draining 3,750 square miles in Subarea 2B, and receives all the runoff from Subarea 2A.

The discharge and quality of the water in the Colorado River entering Subarea 2B is described in the preceding section on Subarea 2A.

Morgan Creek discharges the outflow from Lake Colorado City, (capacity, 38,700 acre-feet) to the Colorado River at mile 785. The quality of water in Lake Colorado City is moderately hard, but otherwise good chemically, according to the analysis of Colorado City's municipal water supply records: total solids, 442 ppm; chlorides, 78 ppm; sulfates, 104 ppm; and hardness, 141 ppm.

Champlin Creek discharges about 2.8 cfs to the Colorado River at mile 781. There are no published records of quality on this tributary.

About 70 miles of Beals Creek lies in Subarea 2B. Beals Creek discharges about 2.3 cfs to the Colorado River at mile 769 (based on a gaging station about two miles downstream from Big Spring). The runoff and quality of Beals Creek is largely determined by several natural salt lakes upstream from the city of Big Spring. A single sample collected August 13, 1958, contained 1,800 ppm dissolved solids, 640 ppm chlorides, 356 ppm sulfates, and 452 ppm hardness. The Texas Department of Health Quality Monitoring station at this point showed a range of 258 - 8,640 ppm dissolved solids, 62 - 2,800 ppm chlorides, and 38 - 1,675 ppm sulfates. This data shows the runoff from Beals Creek to be unsatisfactory as a municipal water supply.

Twenty-six miles downstream from the mouth of Beals Creek, at mile 743, the average flow during water year 1957-58 was 61.0 cfs. Although the quality at this point is slightly better than at mile 794, it still exceeds the adopted chemical criteria for total solids and chlorides; use of this water would also require softening for municipal use (278 ppm hardness).

Oak Creek joins the Colorado River at mile 687. There are no current records of discharge or quality on this tributary. However, Oak Creek Reservoir is located at mile 20; water from this 52,940 acre-feet impoundment is used for water supply by Sweetwater, Blackwell, and Bronte.

At mile 659, the Colorado River had an average flow of 248 cfs during water year 1957-58. Discharge and quality reflect the upstream diversions for irrigation, municipal supplies, and oil field production. Total solids ranged from 1,056 to 2,730 ppm; chlorides from 296 to 1,000; and sulfates from 170 to 575 ppm.

Subarea 2E

Subarea 2F includes 186 miles of the main stem of the Colorado, and drains 2,670 square miles in addition to receiving the runoff from Subareas 2B, 2C, 2D, and 2F.

Traveling downstream from the border of Subareas 2B and 2E, tributaries and subareas join the Colorado at the following river miles: Elm Creek, 658; Subarea 2C (Concho River), 628; Subarea 2D (Pecan Bayou), 513; and Subarea 2F (San Saba River), 479.

There is only one quality station in Subarea 2E, the State monitoring station at mile 561. During 1957-58, the total solids ranged from 234 to 2,700 ppm; chlorides from 40 to 1,000; and sulfates from 27 to 600 ppm.

Elm Creek joins the Colorado River at mile 658, and discharged about 79.1 cfs during 1957-58. The waters of Elm Creek are used for the municipal supply of Ballinger and Winters. Their analyses show this to be a good quality water, having only 228 ppm total solids, but moderately hard (156 ppm).

Subarea 2C

Subarea 2C is the 5,7[illegible]4 square mile watershed of the Concho River. The headwaters of the Concho River consist of the North Concho River and the South Concho River which join to form the Concho River at San Angelo (river mile Concho 61).

At mile 24 on the South Concho River, the water quality appears to be very satisfactory, with the following maximum recorded constituents during 1957-58; total solids, 546 ppm; chlorides 100 ppm; and sulfates, 19 ppm. Average flow was 42 cfs, with a range from 9.1 to 3,360 cfs. Low flows at this station are materially effected by diversions upstream to the South Concho Irrigation Company's Canal. The South Concho River is impounded at its junction with the Middle Concho River to form Lake Nasworthy, a 27,470 acre-feet reservoir used for the San Angelo water supply. In April, 1953, the San Angelo water supply contained 305 ppm total solids; 67 ppm chlorides, 58 ppm sulfates, and 212 ppm hardness.

The Middle Concho River also discharges to Lake Nasworthy. At mile 12, during water year 1957-58, the average discharge was 58.2 cfs; the median values for State Quality Monitoring station were: total solids, 440 ppm; chlorides, 88 ppm; and sulfates, 60 ppm.

Spring Creek discharged about 38.4 cfs to the Middle Concho River at mile 3. There are no quality records for this tributary.

The North Concho River is impounded in the 813,400 acre-feet San Angelo Reservoir. Discharge at mile 56 was 17.7 cfs during water year 1957-58. At mile 24, it increased to 131 cfs. This water, which represents the inflow to San Angelo Dam, had a median chemical quality of 514 ppm total solids; 70 ppm chlorides; and 130 ppm sulfates. After passing through San Angelo Reservoir, the discharge in the North Concho River was 90.6 cfs.

The discharges from San Angelo Reservoir and Lake Nasworthy combine at the confluence of the North and South Concho Rivers. The flow 0.5 mile below this confluence was 215 cfs, and at mile 19, was 241 cfs, containing about 425 ppm total solids, 94 ppm chlorides, and 46 ppm sulfates.

Based on the above flows and quality data, the Concho River discharges about 260 tons of dissolved solids, 61 tons of chlorides, and 30 tons of sulfates daily to the Colorado River at mile 628.

The useful quality of the waters in Subarea 2C is reflected in the extensive use of these waters for irrigation and municipal supply.

Subarea 2D

This is the watershed of Pecan Bayou, and includes the subtributaries Hords Creek and Jim Ned Creek. Pecan Bayou drains about 2,200 square miles to the Colorado River at mile 513.

Hords Creek Reservoir has a capacity of 63,150 acre-feet, and is located about 28 miles upstream from the junction with Pecan Bayou (at Lake Brownwood). The impoundment is used for flood control and as part of the municipal water supply of Coleman. Analyses of this water at Coleman in July, 1952, were: 178 ppm dissolved solids; 14 ppm chlorides; 15 ppm sulfates; and 132 ppm hardness. Only 0.38 cfs was released from Hords Creek Reservoir during the water year 1957-58.

Lake Brownwood is formed by a dam at mile 52 on Pecan Bayou. It has a capacity of 460,000 acre-feet, and is used for irrigation and for municipal and industrial use by the city of Brownwood. Analysis of the Brownwood water supply in May, 1953, showed 178 ppm dissolved solids, 28 ppm chlorides, 20 ppm sulfates, and 116 ppm hardness. During 1958, about 3,860 acre-feet were used for municipal and industrial use, and 2,794 acres were irrigated.

Ten miles downstream from Brownwood Reservoir, the flow in Pecan Bayou was 142 cfs. Median chemical quality at mile 40 was 250 ppm total solids, 52 ppm chlorides, and 25 ppm sulfates.

Pecan Bayou may be expected to discharge an average 142 cfs containing about 96 tons of total solids to the Colorado River at mile 513.

The city of Goldthwaite has seven wells in the Trinity sands, ranging from 50 to 400 feet in depth. A comparison of water from two depths is shown in the following table:

Analysis	Concentration (ppm)	
	90 Ft. Deep	400 Ft. Deep
Total Solids	614	746
pH	7.3	8.0
Alkalinity	293	433
Silica	12	12
Hardness	440	367
Calcium	140	68
Magnesium	22	48
Sodium	30	129
Iron	0.1	0.6
Manganese	*	*
Sulfate	38	157
Chloride	66	92
Fluoride	0.2	0.8
Nitrate	99	2.2

*Less than 0.05

Subarea 2F

This is the San Saba River Basin, draining 3,143 square miles to the Colorado River at mile 479.

At mile 111, the San Saba River discharged 182 cfs containing approximately 332 ppm total solids, 32 ppm chlorides, and 22 ppm sulfates. Almost 3,340 acres were irrigated upstream from this station.

Brady Creek joins the San Saba River at mile 47. At mile 29, Brady Creek had an average flow of 32.5 cfs. There is no published data on the water quality in Brady Creek. The waters are used for municipal supply and extensively for irrigation.

The flow in the San Saba River at mile 15.5 was 422 cfs during the year. Total solids ranged from 240 to 420 ppm, with a mean of 354 ppm. Thus, the San Saba contributed about 400 tons per day of total solids to the Colorado River at mile 479.

Ground waters in Subarea 2F are obtained from the Hickory sands, Trinity sands, and granite wash. The cities of Brady, Menard, and Mason utilize these sources. Brady is the largest consumer of ground water, having used 1,550 acre-feet during 1958. The quality of water from a 2,112 foot well of Brady in Hickory sands is shown in the following table:

Analysis	Concentration (ppm)
Total Solids	402
pH	7.9
Alkalinity	320
Silica	17
Hardness	313
Calcium	53
Magnesium	44
Sodium	40
Iron	0.29
Manganese	less than 0.5
Sulfate	47
Chloride	21
Fluoride	less than 0.4
Nitrate	less than 0.4

Subarea 3B

The Colorado River flows from mile 479 to mile 300 in Subarea 3B, receiving the discharge from Subareas 3A and 3C as well as 2,020 square miles of direct runoff.

At mile 474 (5.2 miles downstream from the San Saba River) the flow was 1,503 cfs during water year 1957-58; it contained 304 ppm dissolved solids (1,230 tons per day), 57 ppm chlorides, 38 ppm sulfates, and 172 ppm hardness.

Buchanan Dam is located at mile 413, has a capacity of 992,000 acre-feet, and is used for power development and irrigation of rice in several districts below Columbus.

Subarea 3A (Llano River) joins the Colorado at mile 300 in the backwaters of Lake Granite Shoals.

Subarea 3C (Pedernales River) joins the Colorado River at mile 354, in the backwaters of Lake Travis, formed by Marsfield Dam at mile 318. Discharge from the dam is not recorded, but contains approximately 319 ppm total solids, 24 ppm chlorides, and 18 ppm sulfates.

Burnet uses wells that are 69 to 180 feet deep. The water is very hard, ranging from 375 to 405 ppm before softening. The city softens the water to 137 ppm.

Subarea 3A

This is the Llano River Basin, which drains 4,490 square miles to the Colorado River at mile 400.

The North Llano River discharged about 155 cfs to the Llano River at mile 110. Quality records are not available for the North Llano River, but the waters are known to be used for irrigation.

The flow in the Llano River at mile 106 was 425 cfs during water year 1957-58. At this point, the total solids were about 292 ppm, chlorides, 28 ppm, and sulfates 23 ppm.

The flow increased to 887 cfs at mile 24, containing about 250 ppm, or 600 tons per day of total solids.

Subarea 3C

This is the Pedernales River watershed, which drains about 2,670 square miles to the Colorado River at mile 354.

The average flow at mile 42 was 332 cfs, containing about 381 ppm (340 tons per day) of total solids.

Small yields from the Trinity sands are available in Subarea 3C. The city of Fredericksburg utilized 640 acre-feet of this water in 1958. The wells were from 42 to 260 feet deep. Quality of water from these depths is shown in the following table:

Analysis	Concentration (ppm)	
	42 Ft. Deep	260 Ft. Deep
Total Solids	981	426
pH	7.3	8.0
Alkalinity	285	285
Silica	14	15
Hardness	583	354
Calcium	126	71
Magnesium	65	43
Sodium	110	55
Iron	0.02	0.04
Manganese	0.1	less than 0.05
Sulfate	67	39
Chloride	328	99
Fluoride	less than 0.4	0.5
Nitrate	5.3	8.0

Subarea 3D

The Colorado River flows from mile 300 to mile 135, draining 2,670 square miles, through Subarea 3D.

At mile 290 (the Austin Water Plant intake) the average discharge during water year 1957-58 was 4,353 cfs. The water at this point contained 24 ppm chlorides, 19 ppm sulfates, 153 ppm hardness, and 216 ppm dissolved solids (2,540 tons per day).

At mile 135, the average discharge was 6,395. There are no quality measurement stations nearby, but the quality is very satisfactory, if judged by the nearest upstream and downstream stations (miles 290 and 67).

Ground waters in Subarea 3D are obtained from Edwards limestone, the lower Oakville formation, and Carrizo-Wilcox formation, and alluvium.

The city of Austin used about 35,000 acre-feet of surface water in 1958.

The city of La Grange used about 370 acre-feet of ground water from the lower Oakville and alluvium. The wells of La Grange are from 192 to 293 feet in depth. Analysis of this water showed the following range in quality:

Analysis	Concentration (ppm)
Total Solids	627-700
pH	7.6-8.0
Alkalinity	290-380
Silica	75- 91
Hardness	24- 97
Calcium	8- 29
Magnesium	1- 6
Sodium	212-281
Iron	0.09-0.30
Sulfate	62- 81
Chloride	85-146
Fluoride	0.4-1.2
Nitrate	less than 0.4

The cities of Bastrop and Smithville obtain their water supplies from the Carrizo-Wilcox and alluvium. Bastrop used 450 acre-feet of ground water from this source during 1958. Bastrop's wells vary from 47 to 58 feet in depth. Samples collected from 1946 to 1952 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	321-530
pH	7.5-8.2
Alkalinity	195-280
Silica	11- 17
Hardness	218-352
Calcium	61-103
Magnesium	7- 23
Sodium	16- 55
Iron	0.06-0.4
Manganese	less than 0.05-0.29
Sulfate	32-108
Chloride	39- 78
Fluoride	0.2
Nitrate	less than 0.4-9.0

Subarea 4

The Colorado River flows from mile 135 to the Gulf through this narrow, 1,640 square mile subarea.

At mile 67, the average flow during water year 1957-58 was 6,128 cfs. This flow contained only 22 ppm chlorides, 22 ppm sulfates, 147 ppm hardness, and 211 ppm dissolved solids (3,490 tons per day).

The average flow at mile 32.6 was about 6,200; quality was the same as at mile 67, and was maintained through mile 7.

Thus, over 6,000 cfs of good quality water was discharged to the Gulf of Mexico during the latest year of record.

Ground water in Subarea 4 is obtained from the Goliad-Willis-Lissie and Beaumont sands. Cities that draw from varying depths of the Beaumont sands include East Bernard, El Campo, Palacios, Wharton, and Eagle Lake. Bay City utilizes the Goliad-Willis-Lissie formation, and Columbus utilizes the Catahoula-Oakville sands.

Bay City is the largest water consumer in this subarea. It used about 1,240 acre-feet during 1958. The wells of Bay City vary in depth from 435 to 811 feet. Analysis of a sample of water collected from the Bay City distribution system in April, 1953, showed the following quality:

Analysis	Concentration (ppm)
Total Solids	360
pH	7.6
Alkalinity	215
Silica	15
Hardness	110
Calcium	26
Magnesium	11
Sodium	92
Iron	0.13
Manganese	less than 0.05
Sulfate	23
Chloride	50
Fluoride	0.6
Nitrate	less than 0.4

El Campo is the largest water user drawing from the Beaumont sands. It used 920 acre-feet of this water during 1958. The wells of El Campo are 1,000 to 1,400 feet in depth. A water sample taken from the distribution system of El Campo in October, 1953, showed the following quality:

Analysis	Concentration (ppm)
Total Solids	385
pH	7.9
Alkalinity	215
Silica	16
Hardness	53
Calcium	13
Magnesium	5
Sodium	138
Iron	0.15
Manganese	less than 0.05
Sulfate	26
Chloride	78
Fluoride	0.4
Nitrate	less than 0.4

The city of Columbus used 450 acre-feet of ground water from the Catahoula-Oakville-Lagarto formations. The wells of Columbus vary from 58 to 284 feet in depth. A water sample collected from the distribution system in December, 1951, showed the following quality:

Analysis	Concentration (ppm)
Total Solids	412
pH	7.5
Alkalinity	250
Silica	19
Hardness	227
Calcium	73
Magnesium	11
Sodium	78
Iron	4.0
Manganese	less than 0.05
Sulfate	39
Chloride	75
Fluoride	0.2
Nitrate	less than 0.4

STATEMENT OF TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE COLORADO RIVER BASIN[*]

Total Number of Sample Stations = 26
Total Number of Samples Taken = 1173
Average Samples/Station = 45

Total Samples "Good" ----------------------------	945 for 80%
Total Samples "Poor" Organically and Chemically ---	72 for 6%
Total Samples "Poor" Organically Only ------------	25 for 3%
Total Samples "Poor" Chemically Only -------------	131 for 11%

Remarks: The Colorado River Basin samples indicate excellent water quality conditions generally, with chemical sources in the upper reaches indicating considerable local influence. The stations in Runnels, Coke, and Mitchell Counties were sampled 122 times with 96 (78%) being in excess of the chemical limits of the survey. This number also is 73% of the total "Poor Chemically" samples of the entire basin. Sixty-four of the 112 samples from Mitchell and Howard Counties accounted for 89% of the "Poor Organically and Chemically" samples of the entire basin.

[*] Presented to the U. S. Study Commission - Texas, June 6, 1960.

TABLE C-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE COLORADO RIVER BASIN

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area*	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1-A	(Noncontributing probably)							
2-A	Colorado River (Lake J. B. Thomas)	845	3,524	220	1953-	---	---	---
	Bull Creek	B-1.5 C-832	388	221	1947-53 1958-	1950-54 (Sporadic after 1951)	---	---
	Bluff Creek	B-1.8	38	222	1947-	1950	---	---
	Colorado River	825	3,617	223	1947-52 1958-	---	---	---
	Deep Creek	DC-8 C-814	178	224	1953-	1953-54	---	---
2-B	Colorado River	796	4,082	225	1923-25 1946-	1946-57	---	---
	Colorado River	795	---	---	---	---	14	1957-60
	Morgan Creek	M-14 C-785	249	226	1954-	---	---	---

*About 2,590 square miles of the Colorado Basin is probably noncontributing.

Table C-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
	Graze Creek	G-1.2 M-11	21.2	227	1954-	---	---	---
	Morgan Creek	M-7	262	228	1947-49	1947-49	---	---
	Morgan Creek (Lake Colorado City)	M-2.5	267	229	1949-	---	---	---
	Champlin Creek	CC-5.5 C-781	158	230	1947-59	1947	---	---
2-B	Beals Creek	---	---	(USGS-1237)	1957-	1956-57	---	---
	Beals Creek	B-53	---	---	---	---	26	1957-60
	Beals Creek	B-12	10,800	---	1958-	---	---	---
	Colorado River	743	15,480	231	1956-	1956-57	---	---
	Colorado River	712	15,770	232	1923-27 1939-56	1939-40 1947-51	13	1957-60
	Oak Creek (Oak Creek Reservoir)	0-20	222	233	1953-	---	---	---

Table C-2 (Continued)

Area	Stream	River Mile	Drainage Area*	U. S. G. S. Discharge Station No. (TBWE)	U. S. G. S. Discharge Period of Record	U. S. G. S. Quality Period of Record	TDH Quality Station No. (TDH)	TDH Quality Period of Record
	Oak Creek	--- C-687	---	---	---	1949-50	---	---
	Colorado River	659	16,840	234	1907-	---	12	1957-60
	Elm Creek	E-1.25 C-658	458	235	1932-	---	---	---
2-E	Colorado River	659	---	---	---	---	---	---
2-C	South Concho	Canal -0	---	236	1939-	---	---	---
	Irrigation Co.'s. Canal (diversion) from S.Concho R.)							
	South Concho River	SC-24 C-61	434	237	1930-	---	23	1957-60
	Middle Concho River	MC-12 SC-8	1,280	238	1930-	---	24	1957-60
	Dove Creek	D-9	---	239	1944-49	---	---	---
	Dove Creek Spring	--- S-8	---	(USGS-1295)	1944-	---	---	---

Table C-2 (Continued)

Area	Stream	River Mile	Drainage Area *	U. S. G. S. Discharge Station No. (TBWE)	U. S. G. S. Discharge Period of Record	U. S. G. S. Quality Period of Record	TDH Quality Station No. (TDH)	TDH Quality Period of Record
	Spring Creek	S-2.8 MC-3	734	240	1930-	---	---	---
	S. Concho River (Lake Nasworthy)	---	2,659	241	1930-	---	---	---
	S. Concho River	SC-1 C-61	2,687	242	1931-53	---	---	---
	N. Concho River	NC-56	690	243	1939-	---	---	---
	N. Concho River	NC-24	---	---	---	---	25	1957-60
	N. Concho River	NC-24	1,533	244	1924-	---	---	---
	N. Concho River (San Angelo Res.)	NC-8	1,790	245	1952-	---	---	---
	N. Concho River	NC-3.2 C-61	1,795	246	1916-31	---	---	---
					1947-			
	Concho River	C-61	4,492	247	1915-	---	---	---
	Concho River	C-33	---	---	---	---	22	1957-60

Table C-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area*	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
	Concho River	C-19 C-628	5,538	248	1915-	---	21	1957-60
2-E	Mukewater Creek	M-6.9	70.4	249	1951-	---	---	---
	Colorado River	561	24,580	250	1923-34 1939-	---	11	1957-60
	Deep Creek Subwatershed No.3	---	3.42	251	1953-	---	---	---
	Deep Creek	--- SS-48	43.9	252	1953-	---	---	---
	Dry Prong Deep Creek (Deep Creek Sub-watershed No. 8)	3.5	4.32	253	1952-	---	---	---
2-E	Dry Prong Deep Creek	DP-1.8	8.31	254	1951-	---	---	---
2-D	Hords Creek (Hords Creek Reservoir)	H-28	48	255	1948-	---	---	---

Table C-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area *	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
	Hords Creek	H-27	53	256	1947-	---	---	---
	Hords Creek	H-14 JN-25 P-11	107	257	1940-	---	---	---
	Brown County Water Improvement District No. 1 Canal	---	---	(USGS-1425)	1950-	---	---	---
	Pecan Bayou (Brownwood Reservoir)	P-52	1,535	258	1933-41 1944-	---	---	---
	Pecan Bayou	P-47	1,614	259	1917-18 1923-	---	---	---
	Pecan Bayou	P-46 C-513	---	---	---	---	20	1957-60
2-F	Noyes Canal	---	---	260	1924-	---	---	---
	San Saba River	SS-111	1,151	261	1915-	---	19	1957-60
	Brady Creek	B-29	575	262	1939-	---	---	---
	San Saba River	SS-15.5 C-479	3,042	263	1915-	---	18	1957-60

Table C-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area*	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3-B	Colorado River	474	30,600	264	1915-22 1923-	1947-57	10	1957-60
	Colorado River (Buchanan Reservoir)	413	31,250	265	1937-	---	---	---
3-B	Colorado River	412	---	---	---	---	9	1957-60
3-A	N. Llano River	NL-4 L-110	914	266	1915-	---	---	---
	Llano River	106	1,874	267	1915-	---	---	---
	Llano River	106	---	---	---	---	17	1957-60
	Llano River	L-38	3,747	268	1923-39	---	---	---
	Llano River	L-24	---	---	---	---	16	1957-60
	Llano River	L-23.6 C-400	4,233	269	1939-	---	---	---
3-C	Pedernales River	P-59	647	270	1924-34	---	---	---
	Pedernales River	P-42	947	271	1939-	---	15	1957-60

Table C-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area *	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
	Pedernales River	P-5.4 C-354	1,294	272	1923-39	---	---	---
3-B	Colorado River (Lake Travis)	318	38,130	273	1940-	---	8	1957-60
3-D	Barton Springs	B-0.6	---	(USGS-1555)	1894-	---	---	---
	Barton Creek	B-0.6 C-296	---	274	1917-18	---	---	---
	Waller Creek	W-3.3	2.31	275	1955-	---	---	---
	Waller Creek	W-2.1	4.13	276	1954-	---	---	---
	Colorado River	290	38,400	277	1898-	1905-06 1938-44 1947-57	7	1957-60
	Onion Creek	O-11 C-274	337	278	1924-30	---	---	---
	Colorado River	237	---	---	---	---	6	1957-60
	Colorado River	212	---	---	---	---	5	1957-60

Table C-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area*	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
	Colorado River	212	39,880	279	1930-	---	---	---
	Dry Creek (at Buescher L.)	D-1.9	1.48	280	1939-	---	---	---
	Colorado River	174	40,430	281	1939-55	---	---	---
4	Colorado River	135	41,070	282	1916-	1941	4	1957-60
	Colorado River	67	41,380	283	1916-25 1938-58	1944-57	3	1957-60
	Colorado River	33.8	---	---	---	---	2	1957-60
	Colorado River	32.6	41,650	284	1940 1948-	---	---	---
	Colorado River	7	---	---	---	---	1	1957-60

TABLE C-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE COLORADO RIVER BASIN

Col-1	Matagorda County	At Matagorda above intra coastal canal
Col-2	Matagorda County	Bridge, State Hwy. 35 W Bay City (No. 57)
Col-3	Wharton County	Bridge, U.S. Hwy. 59 at Wharton (No. 56)
Col-4	Colorado County	Bridge, U.S. Hwy. 90 E Columbus (No. 55)
Col-5	Bastrop County	Bridge, State Hwy. 71 at Smithville (No. 53)
Col-6	Bastrop County	Bridge, State Hwy. 71 W Bastrop
Col-7	Travis County	Bridge, U.S. Hwy. 183 SE edge of Austin (No. 52)
Col-8	Travis County	Mansfield Dam outlet, F.M. 620 (No. 48)
Col-9	Burnet County	Outlet Buchanan Reservoir, State Hwy. 29 (No. 43)
Col-10	San Saba County	Bridge, U.S. Hwy. 190 E San Saba (No.42)
Col-11	Brown County	Bridge, U.S. Hwy. 377 S. Winchell (No. 27)
Col-12	Runnels County	Bridge, U.S. Hwy. 83 at Ballinger (No. 12)
Col-13	Coke County	Bridge, State Hwy. 208 at Robert Lee (Gaging Station Discontinued)
Col-14	Mitchell County	Bridge, U.S. Hwy. 80 at Colorado City (No. 4)
Col-15	Blanco County	Bridge, Pedernales River, U.S. Hwy. 281 NE Johnson City (No. 47)
Col-16	Llano County	Bridge, Llano River, State Hwy. 16 at Llano (No. 46)
Col-17	Kimble County	Bridge, Llano River, F.M. 385 E Junction (No. 45)
Col-18	San Saba County	Bridge, San Saba River, State Hwy. 16 N San Saba (No. 41)

Table C-2a (Continued)

Col-19	Menard County	Bridge, San Saba River, U.S. Hwy. 83 in Menard (No. 39)
Col-20	Brown County	Bridge, Pecan Bayou, U.S. Hwy. 377 at Brownwood (No. 37)
Col-21	Concho County	Bridge, Concho River, U.S. Hwy. 83 at Paint Rock (No. 25)
Col-22	Tom Green County	Bridge, Concho River, F.M. 380 E San Angelo (No. 24)
Col-23	Tom Green County	Bridge, South Concho River, U.S. Hwy. 277 at Christoval (No. 15)
Col-24	Tom Green County	Bridge, Middle Concho River, U.S. Hwy. 67 NE Tankersly (No. 16)
Col-25	Tom Green County	North Concho River at Sanatorium Dam, Spur, U.S. Hwy. 87 near Carlsbad, Texas (No. 21)
Col-26	Howard County	Bridge, Beals Creek, F.M. 821 E Big Spring near Snyder Oil Field (No. 9)

TABLE C-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL IN THE COLORADO RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 1A									
LOST DRAW									
SULPHUR DRAW									
Morton	---	2,700	3 Wells	0.54	2,000	Dry Lake	---	---	---
Brownfield	---	10,500	11 Wells	1.50	8,600	Land irr. & lagoons	---	---	---
Subarea 2A									
COLORADO RIVER									
O'Donnell	---	1,400	12 Wells	0.125	700	Dry Lake & land irr.	4,590	---	---
SPRING CREEK									
GOLD CREEK									
KATE CREEK									
TRIBUTARY									
BULL CREEK	832								

Table C-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
SILVER CREEK									
TRIBUTARY									
BLUFF CREEK									
WILLOW CREEK									
DEEP CREEK	814								
Fluvanna	---	200	3 Wells	0.02	---	---	---	---	---
Snyder	---	17,610	Thomas L., Colo. R., 14 Wells	2.25	6,000	Lagoons & land irr.	503	288 (Lake Thomas)	---
Subarea 2B									
Colorado City	---	9,090	21 Wells	0.90	6,500	Colorado R.	---	---	---
CHERRY CREEK	797								
CHAMPLIN CREEK	781								
Loraine	---	1,100	4 Wells	0.20	500	Dry Lake	820	480	---
BEALS CREEK	770								
SULPHUR SPRINGS CREEK									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
Subarea 1B									
Plains	---	550	4 Wells	0.18	---	---	1,508	---	---
Seagraves	---	2,600	6 Wells	0.52	2,000	Land irr.	922	820	---
Lamesa	---	14,000	31 Wells	2.0	8,500	Lagoons & land irr.	864	835	---
TRIBUTARY									
MUSTANG DRAW									
SEMINOLE DRAW									
Seminole	---	5,800	6 Wells	1.06	3,200	Land irr.	825	543	---
MONUMENT DRAW									
Florey	---	---	---	---	150	Lagoons	---	---	---
Andrews	---	11,000	10 Wells	1.80	2,100	Lagoons	510	---	---
Stanton	---	2,500	9 Wells	0.53	1,200	Land irr.	---	---	---
JOHNSON DRAW									
Odessa	---	75,000	70 Wells, L. Thomas Reservoir	8.40	60,000	Land & land irr.	480 (wells)	290 (Lake Thomas)	---

Table C-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
TRIBUTARY									
Midland	---	53,000	69 Wells	8.00	36,500	Land irr. Beals Creek	2,200	820	---
Subarea 2B									
Big Spring	---	28,000	Lakes Colo. R. 26 Wells	4.00	15,000	Beals Creek	780 (spring)	280 (Lake Thomas)	---
CRYSTAL CREEK									
ROSS CREEK									
SILVER CREEK									
DOYLE CREEK									
Robert Lee	---	1,200	City lake	0.17	---	---	150	---	---
LIVEOAK									
TRIBUTARY									

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
OAK CREEK	687								
EAGLE CREEK									
Blackwell	---	400	Oak Cr. Lake Sweetwater raw water line	0.03	---	---	---	---	---
MULE CREEK									
VALLEY CREEK									
FISH CREEK									
TRIBUTARY									
Subarea 2E									
Ballinger	---	6,800	Valley Creek	0.75	2,000	Colorado R.	228	205	---
ELM CREEK	658								
BLUFF CREEK									
TRIBUTARY									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
Winters	---	3,800	Lake Winters	0.40	2,200	Lagoon & land irr.	285	204	---
MUD CREEK									
CONCHO RIVER	629								
NORTH CONCHO RIVER	Co-61								
Subarea 2C									
Sterling City	---	865	1 Well	---	---	---	---	---	---
STERLING CREEK									
GRAPE CREEK	NC-18								
San Angelo	---	69,661	Middle North South Concho Rivers	8.20	50,100	Land irr. & lagoons	305	---	---
SOUTH CONCHO RIVER	Co-61								

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
PECAN CREEK	SC-12								
MIDDLE CONCHO	SC-8								
CENTRALIA DRAW	MC-62								
BIG JIM CREEK	MC-62								
Big Lake	---	3,500	7 Wells	0.45	1,000	Big Jim Cr.	2,180	2,050	---
TEPEE DRAW	MC-53								
DRY CREEK									
SPRING CREEK	MC-3								
Barnhart	---	300	3 Wells	0.035	---	---	---	---	---
DOVE CREEK									
REDBANK CREEK	Co-50								
TRIBUTARY OF CONCHO									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Soldis in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
LIPAN CREEK	Co-28								
TRIBUTARY									
TRIBUTARY									
Miles	---	750	3 Wells	0.04	---	---	1,560	664	---
KICKAPOO CREEK	Co-23								
Paint Rock	Co-19	335	Concho	0.02	---	---	---	---	---
GRAPE CREEK									
ELM CREEK									

Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 2E									
Talpa	---	255	Lake	0.03	---	---	284	---	---
MUSTANG CREEK									

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
TRIBUTARY									
SALT CREEK									
TRIBUTARY									
ELM CREEK									
COW CREEK									
CEDAR CREEK									
HOME CREEK									
TRIBUTARY									
CAMP CREEK									
MUKEWATER CREEK									
Santa Anna	---	---	Brown Co. WCID	---	1,350	Land irr.	---	---	---

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
CORN CREEK									
Winchell	561	---	---	---	---	---	---	---	---
DEEP CREEK									
CLEAR CREEK									
Bangs	---	---	Lake Brown Co. WCID #1	---	1,200	Dry Arroyo	1,101	---	---
TRIBUTARY									
ANTELOPE CREEK									
TRIBUTARY									
WILBARGER CREEK									
TRIBUTARY									
PECAN BAYOU	513								

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
MIDDLE FORK									
TRIBUTARY									
Subarea 2D									
Burkett	---	150	Pecan Bayou, L. Brownwood, Trib.	---	---	---	---	---	---
GREENBRIER CREEK									
Cross Plains	---	1,500	27 Wells	0.10	1,200	Land irr. & lagoons	750	577	---
TRIBUTARY									
JIM NED CREEK	PB-11								
Tuscola	---	500	3 Wells	0.04	---	---	---	---	---
Lawn	---	300	1 Well	0.025	---	---	---	---	---

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
TRIBUTARY									
TRIBUTARY									
Novice	---	200	Lake (imp.)	0.015	---	---	---	---	---
TRIBUTARY									
HORDS CREEK	JN-25								
Coleman	H-14	7,000	Indian Cr., Hords Cr.	0.74	5,000	Land irr. & lagoons	178	165	---
MUD CREEK									
TRIBUTARY									
TRIBUTARY									
SALT CREEK									
Brownwood	48	---	Brown Co. WCID #1	---	15,000	Pecan Bayou	---	---	---
TRIBUTARY									

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
BLANKET CREEK									
Blanket	---	350	2 Wells	0.02	---	---	---	---	---
MULLIN CREEK									
BULL CREEK									
Goldthwaite	---	1,695	6 Wells	0.152	1,000	Lagoons	746	614	---
SAN SABA RIVER	479								
NORTH VALLEY PRONG									
Subarea 2F									
Eldorado	---	1,750	3 Wells	0.35	650	Lagoons	283	264	---
MIDDLE VALLEY PRONG									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
ROCKY CREEK									
DRY CREEK									
LAS MORAS CREEK									
Menard	SS-111	3,000	San Saba	0.20	400	San Saba	322	273	---
TRIBUTARY									
TRIBUTARY									
LOAFER CREEK									
DEER CREEK									
DEEP CREEK									
BRADY CREEK									
Eden	---	2,000	2 Wells	0.128	---	---	1,105	465	---
Melvin	---	600	1 Well	0.11	---	---	---	---	---
SOUTH FORK									
TRIBUTARY									
Brady	---	6,914	4 Wells	2.20	5,800	Land irr. & lagoons	402	376	---

Table C-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
ONION CREEK									
TRIBUTARY									
TRIBUTARY									
Richland Springs	---	580	Well & Spring	0.047	---	---	---	---	---
San Saba	---	3,400	3 Wells & San Saba Springs	0.30	2,000	Lagoons & irr.	703	---	---
SIMPSON CREEK									
JERRY BRANCH									
TRIBUTARY									
SALT CREEK									
CHEROKEE CREEK									
LYNCH CREEK									

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
FALL CREEK									
BEAVER CREEK									
MORGAN CREEK									
PETER CREEK									
LLANO RIVER	400								
NO. LLANO RIVER									
EPPS CREEK									
BEAR CREEK									
Subarea 3A									
Junction	---	2,700	2 Wells	0.60	1,430	Irrigation	293	---	---
SOUTH LLANO RIVER									

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
JUNCTION FORK									
BEAR CREEK									
SALINAS CREEK									
TRIBUTARY									
HONEY CREEK									
JAMES RIVER									
EAST FORK									
SCHEP CREEK									
COMANCHE CREEK									
Mason	---	2,500	2 Wells	0.16	1,070	Lagoons	278	---	---
BEAVER CREEK									
THREADGILL CREEK									
TRIBUTARY									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
SQUAW CREEK									
WILLOW CREEK									
MARTIN CREEK									
ELM CREEK									
HICKORY CREEK									
SAN FERNADO CREEK									
JOHNSON CREEK									
PECAN CREEK									
Llano	L1-24	3,200	Llano (imp)	0.34	750	Llano River	265	252	---
LITTLE LLANO RIVER									
HONEY CREEK									
SANDY CREEK	394								

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
CRABAPPLE CREEK									
COAL CREEK									
TRIBUTARY									
WHITE CREEK									
WALNUT CREEK									
SLICKROCK CREEK									
TRIBUTARY									
Subarea 3B									
Marble Falls	383	1,400	Colo.	0.13	---	---	340	294	---
HAMILTON CREEK									
Burnet	---	2,500	2 Wells	0.12	500	Land irr. & lagoons	470	165	---
DOUBLEHORN CREEK									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
TRIBUTARY									
TRIBUTARY									
PEDERNALES RIVER	354								
WHITE OAK CREEK									
SPRING CREEK									
WOLF CREEK									
BEAR CREEK									
LIVE OAK CREEK									
BARRONS CREEK									
Subarea 3C									
Fredericksburg	---	5,555	3 Wells	1.25	3,900	Lagoons & land irr.	902	426	---
GRAPE CREEK									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Source	Use mgd	Waste Disposal Population Served 1957	Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
TRIBUTARY									
NO. GRAPE CREEK									
TRIBUTARY									
TRIBUTARY									
Johnson City	---	700	4 Wells	0.175	600	Lagoon	504	---	---
MILLERS CREEK									
TRIBUTARY									
CYPRESS CREEK									
FALL CREEK									
COW CREEK									
SANDY CREEK									
BARTON CREEK	296								

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 3D									
Austin	292	186,000	Colo. (L. Austin)	32.90	160,000	Colorado	---	214	---
TRIBUTARY									
McNeil	---	---	(Austin)	---	---	---	---	---	---
ONION CREEK	274								
Buda	---	480	1 Well	0.21	---	---	---	---	---
TRIBUTARY									
SLAUGHTER CREEK									
WILLIAMSON CREEK									
GILLELAND CREEK									
Pflugerville	---	350	1 Well	0.02	---	---	---	---	---
Manor	---	820	1 Well	0.035	236	Gilleland Cr.	1,880	---	---

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
DRY CREEK									
WILBARGER CREEK									
BIG SANDY CREEK									
TRIBUTARY									
Elgin	---	3,600	2 Wells	0.314	2,750	Town branch	269	167	---
PINEY CREEK	238								
Bastrop	234	3,800	5 Wells	0.394	2,500	Colorado Ri.	530	321	---
WALNUT CREEK	224								
CEDAR CREEK									
MAYHARD CREEK									
Cedar Creek	---	275	1 Well	0.01	---	---	---	---	---
PINEY CREEK									

Table C-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
ALUM CREEK									
Smithville	207	4,200	3 Wells	0.387	1,600	Colorado Ri.	725	522	---
TRIBUTARY									
PINOAK CREEK									
KNOBBS CREEK									
RABBS CREEK	187								
LaGrange	---	2,800	6 Wells	0.328	2,200	Colorado R.	795	627	---
BUCKNER CREEK									
LIVEOAK CREEK									
PINOAK CREEK									
TRIBUTARY									
WILLIAMS CREEK									

Table C-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
Ellinger	---	220	1 Well	0.005	---	---	---	---	---
Subarea 4									
Columbus	138	3,000	2 Wells	0.426	1,800	Colorado R.	570	383	---
CUMMINS CREEK	137								
Subarea 3D									
Giddings	---	2,600	4 Wells	0.174	2,800	Nails Cr. to Yegua Cr. to Brazos R., Sandy Cr. to Roats Cr.	1,280	502	---
TRIBUTARY									
Fayetteville	---	600	1 Well	0.024	450	Pools Br. of Colo. R.	638	---	---

Table C-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
Subarea 4									
Eagle Lake	---	3,800	2 Wells (Drilled)	0.278	2,200	Eagle Lake & land irr.	260	190	---
SCULL CREEK	109								
Wharton	67	6,000	3 Wells	0.769	6,000	Colorado R.	337	322	---
JONES CREEK	49								
BLUE CREEK	37								
Matagorda	8	600	1 Well (artesian)	0.026	200 (summer)	Tidewater	766	---	---
MATAGORDA BAY									

TABLE C-4

SALINE GROUND WATERS IN THE COLORADO RIVER BASIN

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1A - Colorado River	Tr12	Lynn	1,270	820	3,280	Dockum Group	S	---	Colorado River
	K90	Lynn	685	222	1,890	Edwards Limestone	P	---	Colorado River
	15	Lynn	418	320	1,390	Ogallala Formation	Irr.	65	Colorado River
	16	Lynn	667	2,050	4,590	Ogallala Formation	S	---	Colorado River
	17	Lynn	543	555	1,820	Ogallala Formation	Irr.	---	Colorado River
	18	Lynn	1,560	400	3,160	Ogallala Formation	D, S	68½	Colorado River
	19	Lynn	5,970	5,920	17,400	Ogallala Formation	Irr.	64½	Colorado River
1B - Beals Creek	C05	Ector	2,640	46,600	85,800	Ellenburger Group	---	---	Johnson Draw
Johnson Draw	6	Ector	48	24,700	45,480	Ellenburger Group	---	---	Creek

*D, domestic; S, stock; Ind, industrial; Irr, irrigation; P, public supply; N, none.

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
Mustang Draw	7	Andrews	1,375	24,350	44,140	Ellenburger Group	---	---	Creek
	8	Andrews	2,640	37,500	69,550	Ellenburger Group	---	---	Creek
	9	Andrews	100	156,100	286,700	Ellenburger Group	---	---	Creek
Beals Creek	Tr1	Ector	2,440	2,140	7,190	Dockum Group	N	---	Johnson Draw
	2	Ector	1,580	2,710	7,010	Dockum Group	S	---	Johnson Draw
	3	Ector	484	395	1,890	Dockum Group	S	---	Johnson Draw
Johnson Draw	01	Midland	220	365	1,120	Ogallala Formation	Irr.	69	Creek
	2	Midland	824	240	1,750	Ogallala Formation	---	---	Creek
	3	Midland	378	273	1,220	Ogallala Formation	P	67½	Creek
Mustang Draw	4	Andrews	587	375	1,740	Ogallala Formation	S	---	Creek

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
	5	Martin	322	378	1,320	Ogallala Formation	Irr.	---	Creek
Beals Creek	6	Howard	335	590	1,680	Ogallala Formation	P	---	Creek
Colorado River	7	Dawson	254	472	1,410	Ogallala Formation	---	---	Spring Creek
Sulphur Springs Creek	11	Yoakum	779	102	1,490	Ogallala Formation	P	---	Sulphur Springs Creek
Mustang Draw	12	Gaines	931	615	2,490	Ogallala Formation	D, S	---	McKenzie Draw
Sulphur Springs Creek	13	Terry	373	254	1,120	Ogallala Formation	S	---	Sulphur Springs Creek
	14	Terry	301	320	1,160	Ogallala Formation	S	---	Sulphur Springs Creek
2A - Colorado River	CO10	Scurry	1,940	35,400	63,000	Ellenburger Formation	---	---	Deep Creek

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
	P72	Borden	1,730	2,080	6,440	Quatermaster Formation	S	---	Colorado River
	Tr9	Scurry	1,700	1,840					
	Tr9	Scurry	1,700	1,840	5,880	Dockum Group	S	---	Bull Creek
	10	Scurry	1,620	680	3,550	Dockum Group	S	---	Bull Creek
	11	Scurry	2,660	382	4,580	Dockum Group	S	---	Bull Creek
	14	Borden	239	312	1,160	Dockum Group	D, S	---	Gold Creek
Bull Creek	15	Borden	208	1,140	2,380	Dockum Group	D, S	---	Silver Creek
	16	Borden	1,620	460	3,580	Dockum Group	S	---	Creek
Colorado River	18	Borden	2,410	4,300	10,800	Dockum Group	Ind.	---	Creek
	19	Borden	3,200	8,020	17,700	Dockum Group	N	73.5	Colorado River
Bull Creek	08	Borden	181	238	1,280	Ogallala Formation	D, S	---	Creek

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
Bull Creek	9	Borden	260	282	1,100	Ogallala Formation	D, S	66	Creek
Colorado River	10	Scurry	305	407	1,610	Ogallala Formation	S	---	Bluff Creek
2B - Colorado River	P26	Coke	---	30,000	>1,000	San Angelo Sandstone	---	---	Colorado River
	27	Coke	1,560	624	3,450	San Angelo Sandstone	---	---	Creek
	28	Nolan	640	130	1,340	San Angelo Sandstone	D	---	Oak Creek
	Tr4	Mitchell	492	220	1,270	Dockum Group	---	---	Colorado River
	5	Mitchell	1,480	103	2,370	Dockum Group	Irr.	---	Champlin Creek
	6	Mitchell	935	2,210	5,190	Dockum Group	---	---	Colorado River
	7	Mitchell	998	3,150	6,800	Dockum Group	---	---	Colorado River
	8	Mitchell	1,650	3,510	8,390	Dockum Group	---	---	Colorado River

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
	17	Mitchell	1,390	2,540	6,510	Dockum Group	---	---	Colorado River
	R12	Mitchell	543	65	1,240	Alluvium	P	---	Colorado River
2C - Middle Concho River	P25	Tom Green	3,180	29,500	52,400	San Angelo Sandstone	---	---	Middle Concho River
Brady Creek	C01	Concho	23	400	1,110	Hickory Sandstone	P	127	Creek
Middle Concho River	4	Reagan	1,020	92,100	143,000	Ellenburger Group	---	---	Creek
Concho River	P8	Tom Green	1,470	1,990	5,300	Wichita and Clear Fork Group	S	---	Concho River
	9	Tom Green	1,930	185	3,020	Wichita and Clear Fork Group	S	---	Concho River
Concho River	10	Tom Green	1,760	185	2,960	Wichita and Clear Fork Group	Irr.	70	Concho River
	11	Tom Green	1,060	126	1,870	Wichita and Clear Fork Group	Irr.	70	Concho River

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
Middle Concho River	K42	Upton	545	108	1,230	Trinity Group	P	---	Creek
	43	Upton	919	165	1,820	Trinity Group	P	---	Creek
	44	Reagan	704	760	2,450	Trinity Group	P	69½	Creek
	45	Reagan	985	144	1,840	Trinity Group	P, Ind.	80	Creek
	46	Reagan	813	112	1,540	Trinity Group	P, Ind.	69	Creek
	47	Reagan	947	244	1,940	Trinity Group	P	69	Creek
2E - Colorado River	C1	McCulloch	19	385	1,030	Pennsylvanian Undifferentiated	---	---	Creek
	2	McCulloch	14	400	1,050	Pennsylvanian Undifferentiated	---	---	Creek
Brady Creek	12	McColloch	10	3,310	5,640	Pennsylvanian Undifferentiated	---	---	Creek
Colorado River	P12	Runnels	584	201	1,390	Wichita and Clear Fork Group	P	---	Creek
2F - San Saba	CO2	San Saba	2,550	24,050	45,800	Ellenburger Group	---	---	Simpson Creek

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
3B - Colorado River	C14	Burnett	129	19,200	31,300	Pennsylvanian Undifferentiated	S	---	Colorado River
	K4	Travis	1,310	27	2,120	Travis Peak Formation	---	---	Colorado River
3D - Colorado River	K3	Travis	877	43	1,520	Travis Peak Formation	D	---	Williamson Creek
	5	Travis	598	1,290	3,420	Travis Peak Formation	D	---	Creek
Onion Creek	25	Hays	802	70	1,510	Glen Rose Limestone	D	---	Creek
	26	Travis	1,240	33	2,020	Glen Rose Limestone	---	---	Colorado River
Onion Creek	51	Hays	896	54	1,580	Trinity Group	---	---	Creek
Colorado River	52	Travis	739	270	1,910	Trinity Group	P	110	Creek
	53	Travis	523	62	1,110	Trinity Group	D	---	Colorado River
	85	Travis	2,010	1,450	5,400	Edwards Limestone	D, S	---	Colorado River

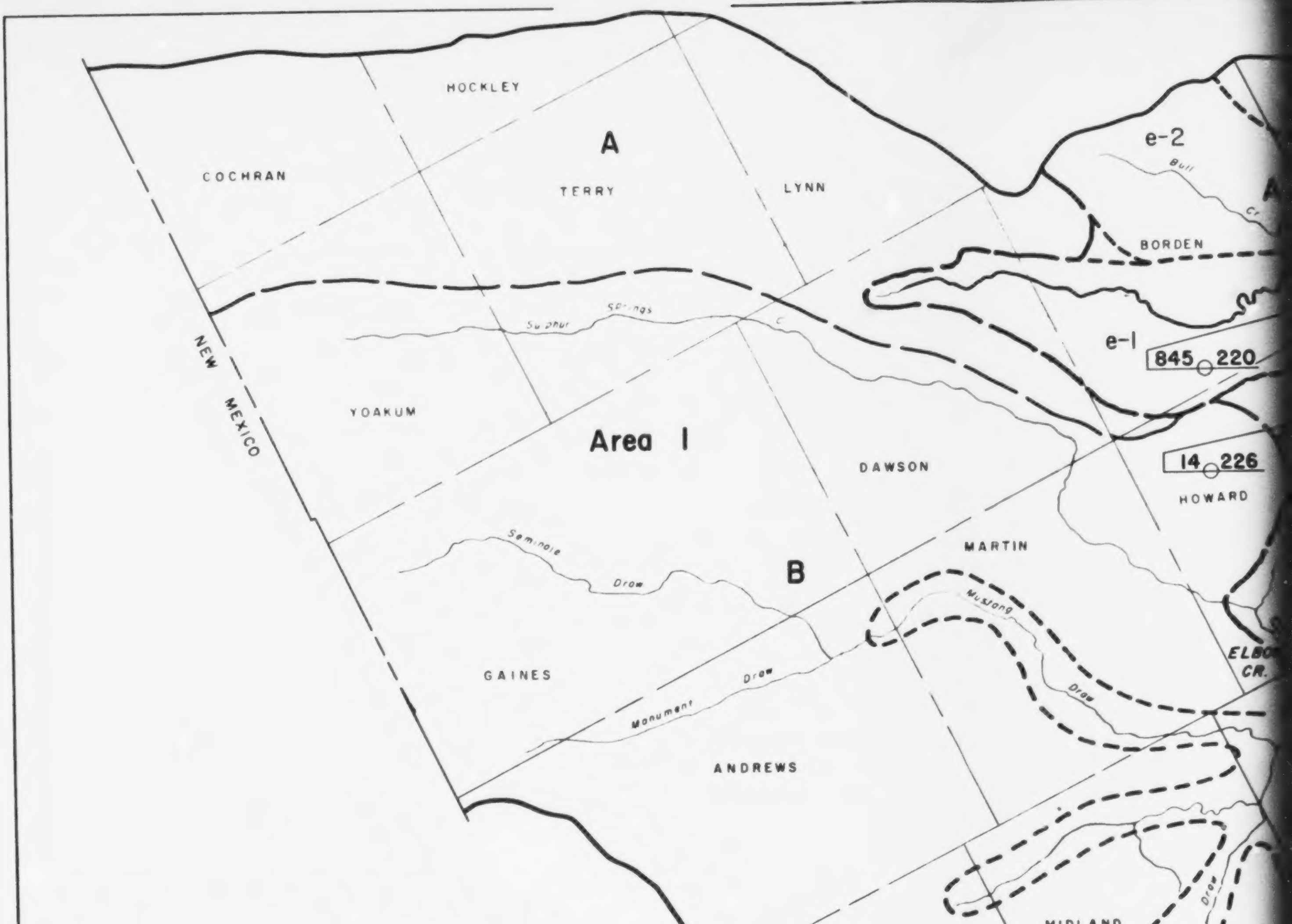
TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
Colorado River	86	Travis	2,750	3,830	10,200	Edwards Limestone	N	---	Colorado River
	87	Travis	93	458	1,050	Edwards Limestone	D, S	---	Colorado River
	E4	Bastrop	928	272	1,990	Wilcox Group	D	---	Cedar Creek
	5	Bastrop	4	450	1,350	Wilcox Group	N	---	Colorado River
	6	Bastrop	1,640	235	2,620	Wilcox Group	N	---	Pireoy Creek
	7	Bastrop	967	3,400	6,580	Wilcox Group	---	---	Creek
	8	Bastrop	46	580	1,120	Wilcox Group	D, S	---	Big Sandy Creek
	40	Bastrop	762	1,700	3,890	Carrizo Sand	S	75	Pinoak Creek
	41	Bastrop	858	185	1,700	Carrizo Sand	D, S	---	Alum Creek

TABLE C-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
Colorado River	50	Bastrop	1,080	370	2,050	Queen City Sand	N	---	Piney Creek
	60	Bastrop	621	337	1,890	Mount Selman Formation	--	--	Pinoak Creek
	61	Lee	557	640	2,090	Sparta Sand	D, Irr.	---	Rabbs Creek
Area of Matagorda Bay	B9	Matagorda	19	1,140	2,060	Beaumont Clay	P	---	Tidewater
Tidewater	10	Matagorda	3	358	1,320	Beaumont Clay	D, S	---	Liveoak Creek

A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Monument Draw
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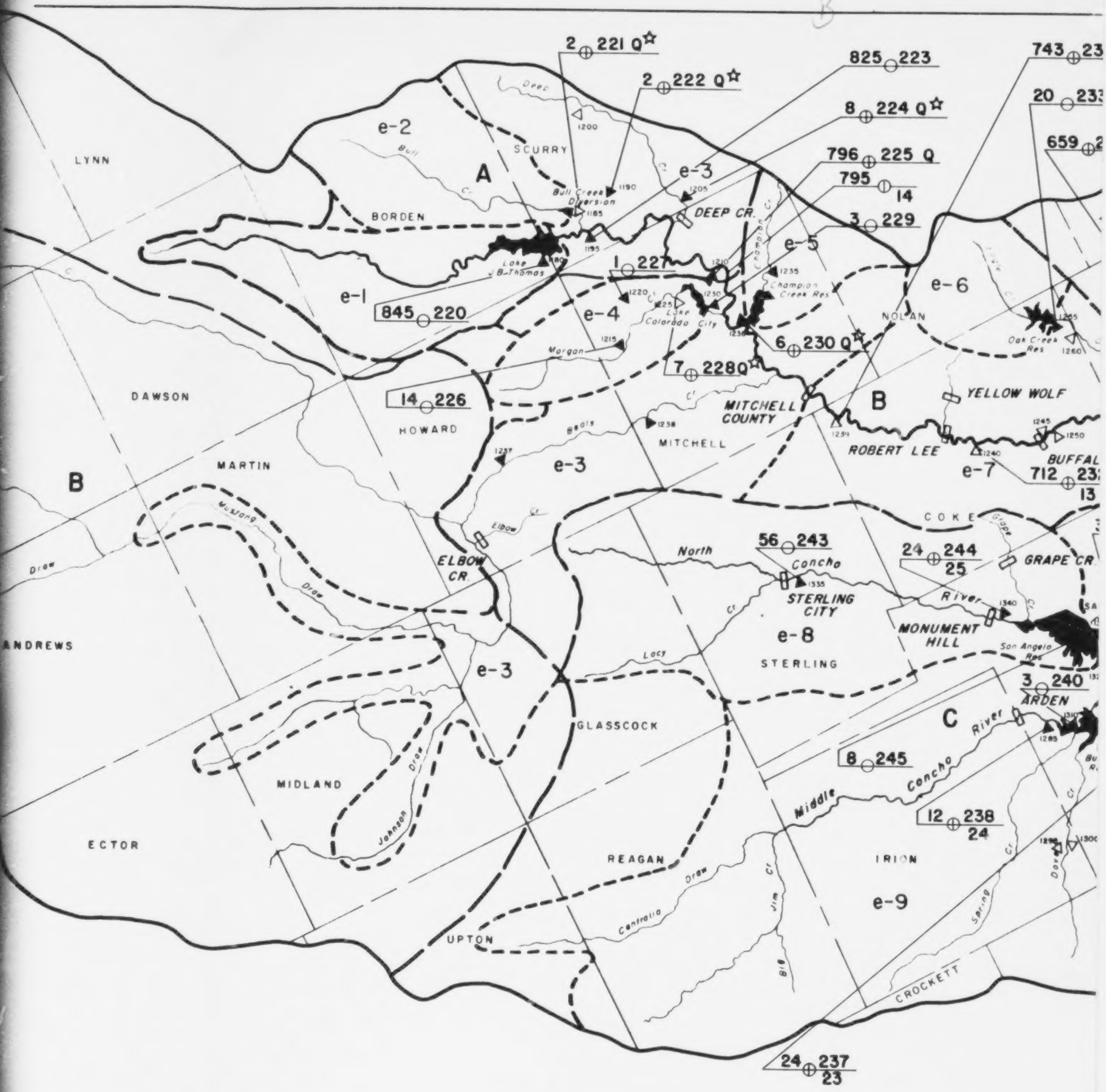
U.S. STUDY COMMISSION-TEXAS C 55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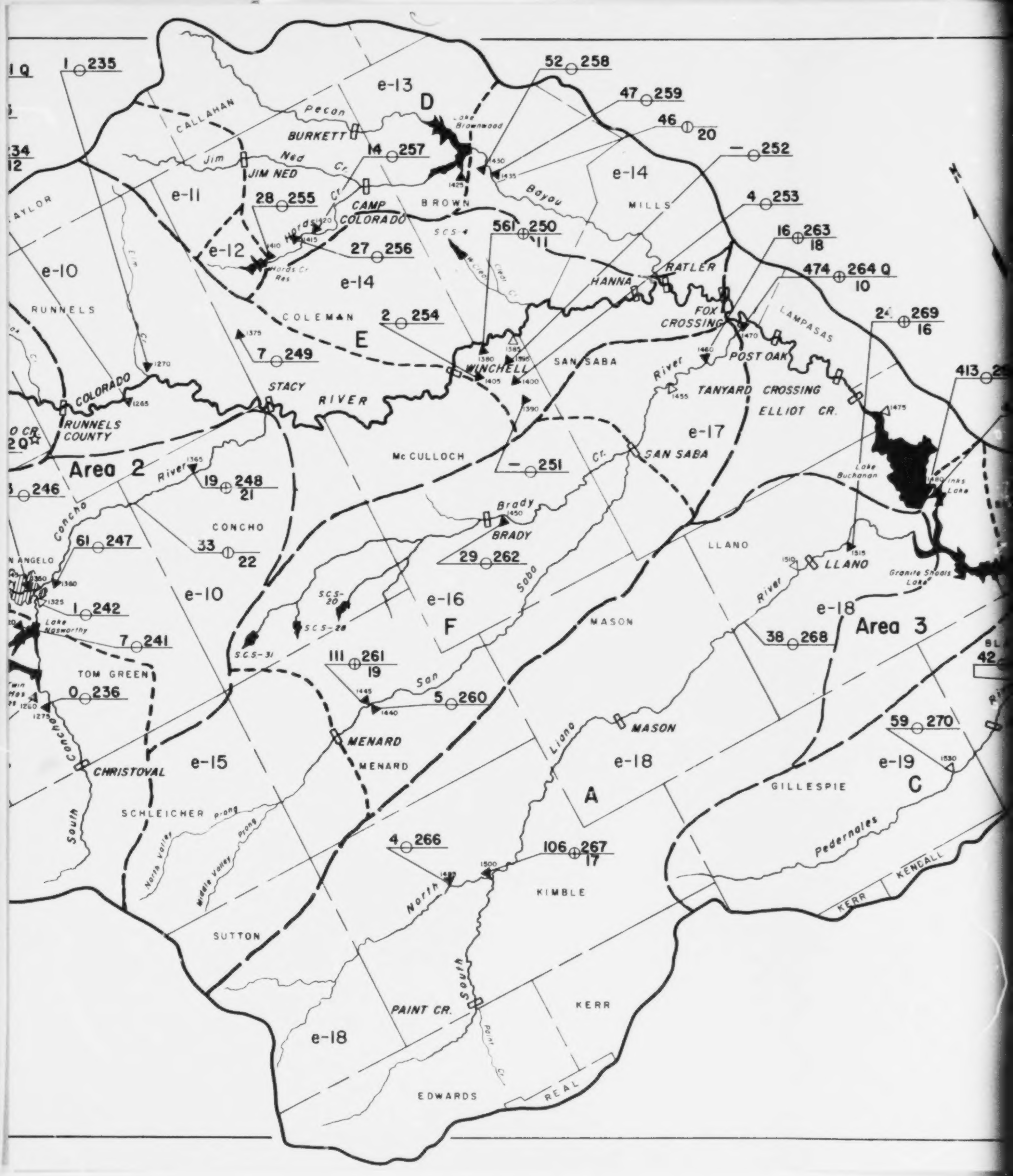
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CALLAHAN
Pecan
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MILLS
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Lake Buchanan
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Area 2
River
19 248 21
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Concho
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Brady
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61 247
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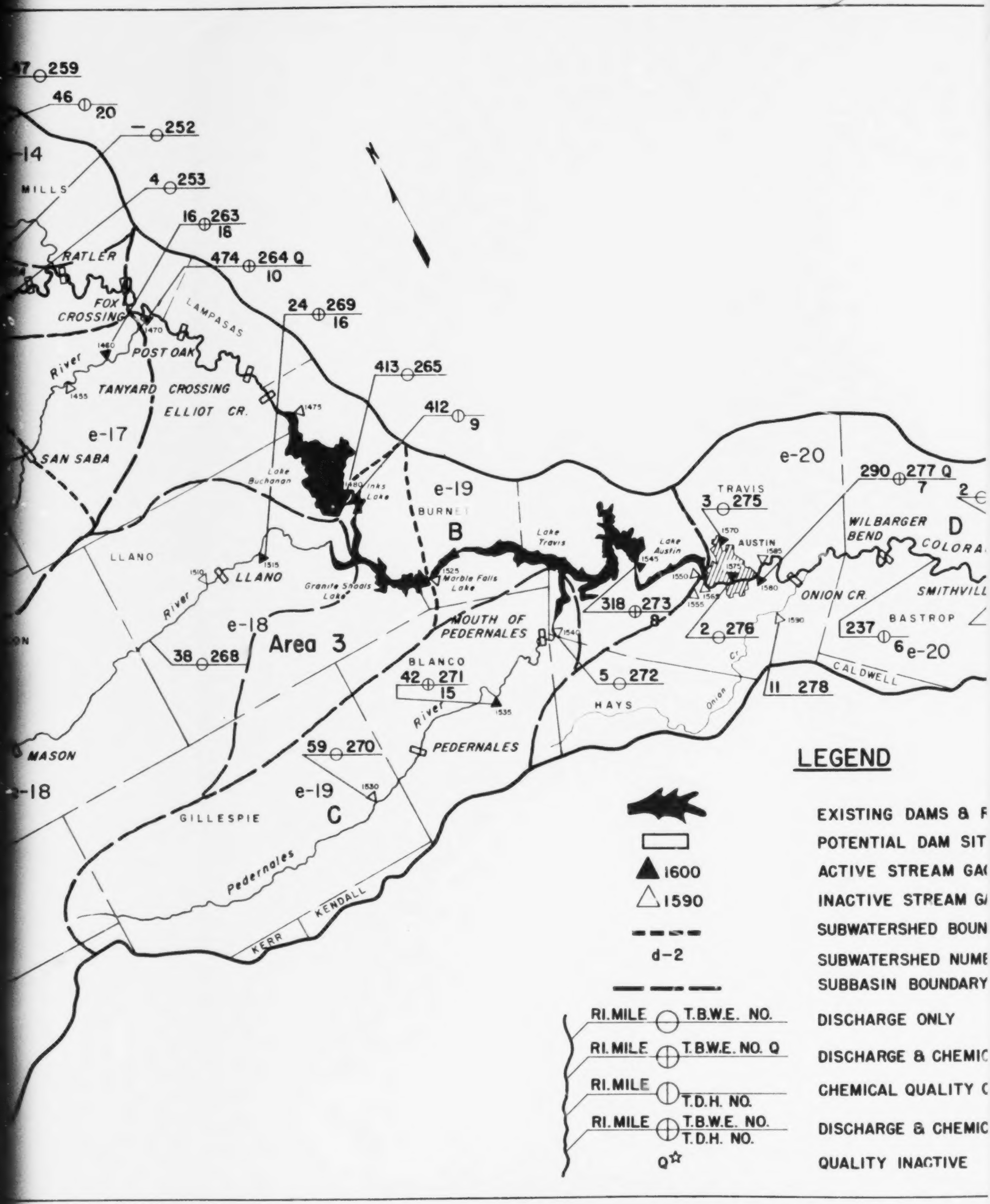
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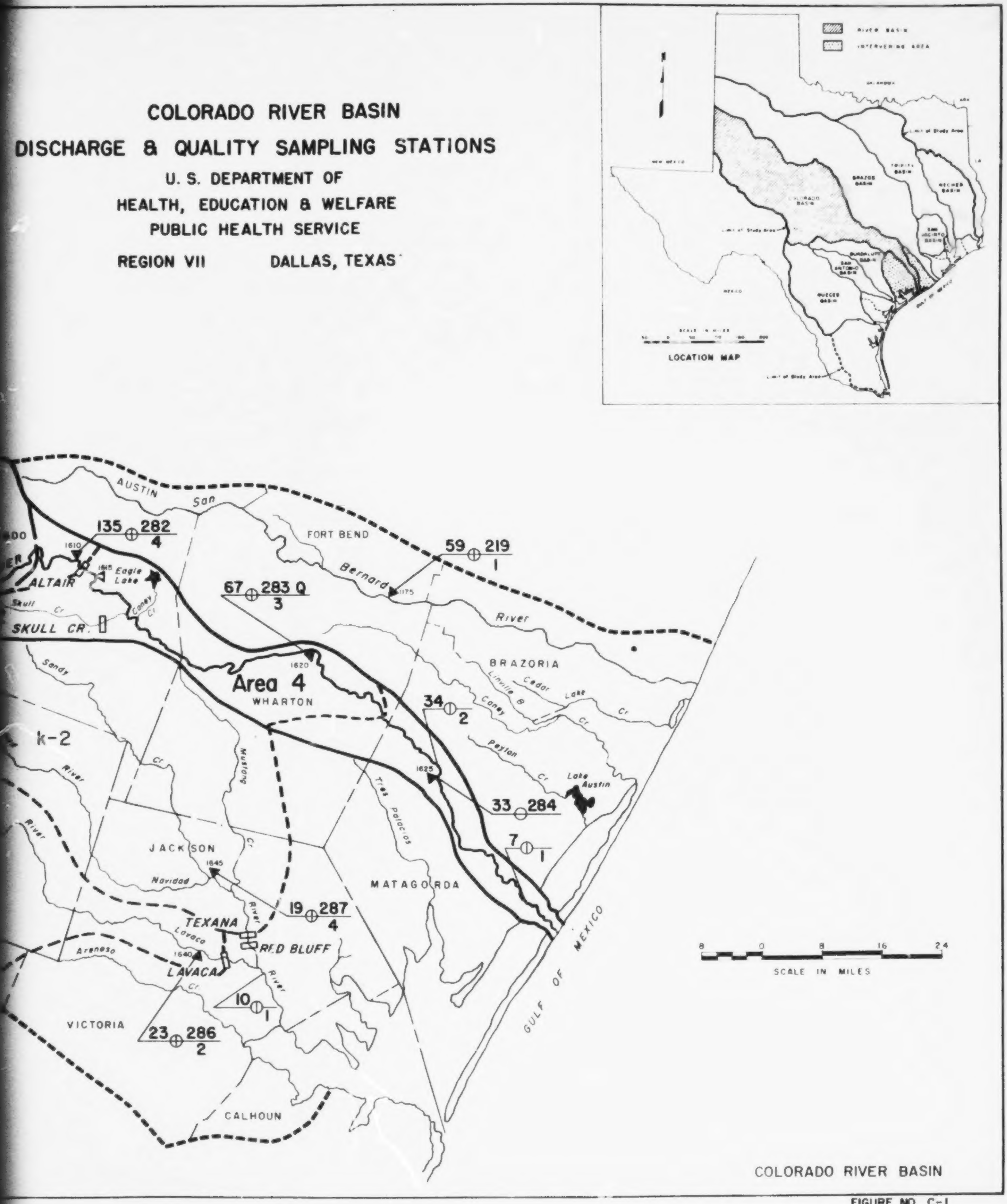
142-A

COLORADO RIVER BASIN
DISCHARGE & QUALITY SAMPLING STATIONS

U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS


RIVER BASIN
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OKLAHOMA
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COLORADO BASIN
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SAN JACINTO BASIN
GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
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Limit of Study Area
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SCALE IN MILES
LOCATION MAP
AUSTIN
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FORT BEND
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ALTAIR
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Caney Cr
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67 283 Q 3
BRAZORIA
Linville B
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7 1
JACKSON
1645
Navidad
River
19 287 4
MATAGORDA
TEXANA
Lavaca
Arenoso
1640
RED BLUFF
LAVACA
Cr
River
10 1
VICTORIA
23 286 2
CALHOUN
GULF OF MEXICO
8 0 8 16 24
SCALE IN MILES

COLORADO RIVER BASIN

FIGURE NO. C-1

GUADALUPE RIVER BASIN

Present Quality of Water Resources in the Guadalupe River Basin

Section, or Subarea	Page
Physical Description	143
1	144
2	145
4	146
3	147
5	150
6	150
7	152
8	152
Statement of Texas Department of Health	153

Physical Description

Geography

The Guadalupe River Basin, relatively long and narrow, has a length of about 237 miles and a width which varies from 18 miles in the headwaters to a maximum of about 56 miles in the vicinity of Gonzales, and then decreases to about five miles near its mouth. The 6,032 square mile watershed is bounded by the watersheds of the San Antonio on the south, the Nueces on the west, the Colorado on the north and northeast, and the Lavaca on the east.

Topography

The 432 miles of the Guadalupe River pass through two distinct physiographic regions; the upper part is the Edwards Plateau region of the North Central Plains, and the lower part is the Gulf Coastal Plains. The two regions are separated by the Balcones Escarpment.

Rainfall-Runoff

Average annual rainfall varies from about 25 inches in the headwaters to about 40 inches near the coast. Excluding runoff from the San Antonio River, the Guadalupe discharges 961,000 acre-feet to the Gulf annually.

Impoundments

As of June, 1958, there were 24 major impoundments with a total capacity of 5,014,100 acre-feet, and 93,118 minor impoundments with a total capacity of 354,000 acre-feet; the latter for various purposes, including municipal, industrial, agricultural, power, and recreation.

TABLE G-1

GUADALUPE RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure G-1)

1. Guadalupe River from mile 430 to mile 405.
   Includes North and South Forks which join to form Guadalupe at mile 430.

2. Guadalupe River from mile 405 to mile 287.

4. Guadalupe River from mile 287 to mile 175.

3. Guadalupe River from mile 175 to mile 170.
   Includes Blanco and San Marcos River Basins.

5. Guadalupe River from mile 170 to mile 105.

6. Guadalupe River from mile 105 to mouth (San Antonio Bay).

Present Quality of Surface and Ground Waters In Subareas of Guadalupe River Basin

Subarea 1

The Guadalupe River rises in this 850 square mile subarea at the confluence of the North and South Forks. It then flows 26 miles to Subarea 2, passing through the city of Kerrville.

There are no quality or discharge records available for the North or South Forks.

Johnson Creek discharged about 31.8 cfs to the Guadalupe River at mile 426 during water year 1957-58. There are no quality data for this tributary.

At mile 425, the State Quality Monitoring station showed the water to be of excellent quality, with total solids ranging from 200 to 339 ppm. There are no discharge gages on the main stem of the Guadalupe to correspond with these quality data.

Kerrville is located at mile 419. It should have no affect on the Guadalupe River, since its 13,500 population obtains municipal water from wells and discharges all treated wastes to land irrigation.

Ground waters in Subarea 1 are obtained primarily from the Travis Peak and Hosston sands.

The city of Kerrville obtains its water supply from nine wells, 600 to 725 feet deep. A sample collected from the distribution system in July, 1948, showed the following quality:

Analysis	Concentration (ppm)
Total Solids	458
pH	7.8
Alkalinity	305
Silica	14
Hardness	381
Calcium	80
Magnesium	44
Sodium	21
Iron	0.12
Sulfate	79
Chloride	28
Fluoride	0.9
Nitrate	less than 0.4

Subarea 2

The Guadalupe River flows from mile 405 to 287 through this 670 square mile subarea. There are no major cities or tributaries. The outstanding physical feature is Canyon Reservoir, under construction at mile 303, which will have a total capacity of 1,129,300 acre-feet.

The city of Comfort is located at mile 398, but should have no effect on the river since it obtains its water supply from wells and discharges its treated waste to land irrigation.

A discharge gage and quality monitoring station at mile 397 show 358 cfs of very good quality water (total solids 204 to 375 ppm) passing this point during water year 1957-58. The long term discharge (1939-58) was 121 cfs.

At mile 334, corresponding discharges were 790 cfs (1957-58) and 259 cfs (1922-58).

Subarea 4

The Guadalupe River flows 112 miles, from mile 287 to mile 175 through this 112 square mile subarea.

A discharge gage at mile 282 recorded 1,033 cfs entering Subarea 4 from Subarea 2 during water year 1957-58. Irrigation is practiced upstream, but there is no indication of quality degradation.

Comal Creek discharges 299 cfs of good quality water (total solids ranged from 246 to 342) during the latest year of record. Diurnal fluctuations in discharge occur due to operation of a steam power plant one-half mile upstream. New Braunfels is located on Comal Creek, but discharges its treated wastes to the Guadalupe River at mile 278.

At mile 279, one mile below the mouth of Comal Creek, and a mile upstream from the New Braunfels outfall, the water quality is even better than it was at mile 397. A gage was operated from 1915 to 1927 at this station, recording an average 751 cfs.

The city of Seguin is located at mile 258. Seguin obtains its water supply from the Guadalupe and discharges treated wastes having a population equivalent of 280 to the Guadalupe at mile 255. Analysis of Seguin's water supply made in January, 1954, showed the water in the Guadalupe to be hard (250 ppm), but otherwise of good chemical quality; total solids, 305 ppm; chlorides, 25 ppm; and sulfates 39 ppm.

Ground waters in Subarea 4 are obtained chiefly from Edwards limestone and Carrizo-Wilcox.

New Braunfels used 6,140 acre-feet of water from Edwards limestone during 1958. Samples collected from the New Braunfels wells (337 and 1,145 feet deep) in 1960 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	284-300
pH	7.3-7.8
Alkalinity	220-235
Hardness	250-262
Calcium	70-79
Magnesium	15-18
Sodium	8-9
Iron	.01-.10
Manganese	less than 0.05
Sulfate	20-23
Chloride	14-21
Fluoride	0.2-0.2
Nitrate	3.7-4.0

Subarea 3

Although Subarea 3 contains only five miles of the main stem of the Guadalupe River, from mile 175 to 170, it covers about 1,380 square miles of the Blanco and San Marcos River Basins. The Blanco River discharges to the San Marcos River at mile 77, and the latter joins the Guadalupe River at mile 176.

There are no major cities or tributaries on the Blanco River. The farthest upstream quality monitoring station is at mile 35. All impurities at this station are well within the adopted criteria, with total solids ranging from 219 to 443 ppm. A discharge gage located at this station recorded an average 356 cfs during water year 1957-58. The long term average (1924-26, 1928-58) was 107 cfs. The flow was about the same 22 miles downstream -- 350 cfs during 1957-58 at mile 13.

The San Marcos River has a quality station and a discharge station at miles 77 and 76 respectively at San Marcos, just upstream from the Blanco River. Much of the discharge (maximum 292, minimum 154, average 215 cfs) represents spring flow. Chemical quality in terms of total solids is good at this station (maximum 393 ppm, minimum 273 ppm, average 346 ppm).

The city of San Marcos discharges sewage plant effluent with a population equivalent of 250 to the San Marcos River at mile 78.

Just downstream from San Marcos, at mile 74, the Blanco River discharges about 350 cfs, as described above.

The cities of Martindale, Staples, Fentress, and Luling are located at miles 68, 63, 54, and 36 respectively. All except Fentress obtain their water from wells; Fentress obtains its supply from the San Marcos River. Luling discharges sewage plant effluent with a population equivalent of 660 from two plants.

Plum Creek joins the San Marcos at mile 19. This is the only tributary of the Guadalupe River which the Texas Department of Health has classified as poor chemically. The single quality monitoring station that accounted for 100 per cent of the "poor" samples was at mile 7 (Station No. Gua-20). Here, the total solids ranged from 276 to 2,250; chlorides from 44 to 560; sulfates from 44 to 240; and BOD from 0.5 to 4.5. The cities of Buda, Kyle, and Lockhart are located on or near Plum Creek upstream from mile 7. Considerable brine producing oil field activity also occurs above this station. Based on discharge and quality records for water year 1957-58, 143 cfs passed this station, containing an average 1,117 ppm total solids, 420 ppm chlorides, and 130 ppm sulfates. This water enters the San Marcos River at mile 26.

At mile 22 on the San Marcos River, an average flow of 456 cfs was recorded during 1915 to 1943. The quality of this stream, three miles upstream from its mouth at mile 176 on the Guadalupe, included about 400 ppm total solids, 62 ppm chlorides, and 35 ppm sulfates.

The city of Gonzales, located at mile 172 on the Guadalupe River, obtains its water supply from this river. Quality of its raw supply, as analyzed in April, 1953, is as follows: 1,142 ppm total solids; 450 ppm hardness; 426 ppm chlorides; and 79 ppm sulfates. Treated wastes having a population equivalent of about 240 are discharged to the Guadalupe River at mile 172.

Ground waters in Subarea 3 are obtained from Edwards limestone and Wilcox-Carrizo alluvium.

San Marcos used about 2,070 acre-feet of water from Edwards limestone during 1958. Samples from two San Marcos wells, 108 feet and 135 feet deep, showed the following quality in 1941-42:

Analysis	Concentration (ppm)
Total Solids	327-365
pH	7.3-7.4
Alkalinity	250-265
Silica	10- 12
Hardness	289-
Calcium	86
Magnesium	18
Sodium	15- 22
Iron	0.02-0.04
Manganese	less than 0.05
Sulfate	27- 31
Chloride	28- 30
Fluoride	less than 0.4
Nitrate	7.5-9.7

The city of Lockhart obtains its water from shallow wells (15 to 24 feet) in alluvium. Samples from these wells collected in 1951 showed the following analyses:

Analysis	Concentration (ppm)
Total Solids	481-705
pH	7.4-7.6
Alkalinity	255-275
Silica	20- 24
Hardness	257-301
Calcium	88-109
Magnesium	7- 9
Sodium	50-116
Iron	0.05-0.08
Manganese	less than 0.05
Sulfate	49-141
Chloride	43-103
Fluoride	0.2-0.5
Nitrate	22- 27

After treatment the total solids were reduced to 386 ppm, hardness to 72 ppm, and alkalinity from 275 to 45 ppm. Nitrates were still excessive, being 26 ppm in the treated water. Lockhart now has several wells in the Carrizo-Wilcox sands which yield a low-nitrate water.

The quality of water from three wells of the city of Luling (depth 310 to 320 feet) is:

Analysis	Concentration (ppm)
Total Solids	1,110-1,220
pH	8.5-8.6
Alkalinity	475-585
Silica	11- 19
Hardness	34- 52
Calcium	7- 11
Magnesium	4- 6
Sodium	419-441
Iron	0.05-0.3
Manganese	less than 0.05
Sulfate	133-222
Chloride	160-185
Fluoride	0.1-0.2
Nitrate	less than 0.4-1.3

Luling used 640 acre-feet of this water during 1958.

The city of Gonzales obtained 760 acre-feet of water from the Guadalupe River. According to W. O. George,(III-2) the city of Gonzales also obtained 760 acre-feet from Carrizo sands during 1958: "The Carrizo-Wilcox is reached at a depth of 1,750 feet in the vicinity of Gonzales, where the water contains excessive amounts of fluoride and sodium bicarbonate."

Subarea 5

In Subarea 5, the Guadalupe River flows from mile 170 to mile 105 and drains an area of 1,390 square miles. Peach Creek joins the Guadalupe at mile 148 and Sandies Creek at mile 105. There are no major cities in this subarea, no quality records, and two discharge gages that have been inactive since 1933.

Ground waters in Subarea 5 are obtained from Carrizo sands and alluvium. The city of Nixon used 290 acre-feet of surface water during 1958.

Subarea 6

The Guadalupe River flows from mile 105 to its mouth in San Antonio Bay in this subarea. Quality influencing features include the cities of Cuero and Victoria and the tributaries Coleto Creek (mile 36) and the San Antonio River (mile 11).

The quality of water entering Subarea 6 from Subarea 5 is indicated by the State Quality Monitoring station at mile 103. Total solids ranged from 121 to 441 ppm, median 363 ppm; chlorides from 12 to 62 ppm, median 48; sulfates 20 to 54 ppm, median 30. A discharge gage was operated at mile 103 from 1903-06, and 1916-35. Average discharge during the period of record was 1,303 cfs.

Cuero obtains its water supply from wells.

The city of Victoria is located at mile 51. Long term quality and discharge records are also available at this river mile. During water year 1957-58, the average discharge was 3,541 cfs, containing 177 ppm hardness, 31 ppm chloride, 27 ppm sulfate, and 264 ppm dissolved solids (2,520 tons per day).

Coleto Creek discharges about 201 cfs (of unknown quality) to the Guadalupe at mile 36.

The San Antonio River discharged about 974 cfs to the Guadalupe River at mile 11.

Below the mouth of the San Antonio River, there are no discharge gages. A quality monitoring station is located at mile 8. At this station, the total solids ranged from 153 to 585 (median 402); chlorides from 20 to 104 (median 72); and sulfates 14 to 62 (median 42). This may be considered the quality of an estimated 4,700 cfs that the Guadalupe discharges to San Antonio Bay and thence to the Gulf.

Ground waters in this subarea include several overlapping formations. In the vicinity of the city of Cuero, the source is the Catahoula-Oakville-Lagarto formation. Cuero used about 880 acre-feet of this water during 1958. Six wells, ranging from 745 to 1,215 feet, showed the following quality for 1948-51:

Analysis	Concentration (ppm)	
	745 Ft. Deep	1,215 Ft. Deep
Total Solids	680	1,058
pH	8.1	7.7
Alkalinity	325	475
Silica	22	24
Hardness	69	89
Calcium	11	24
Magnesium	10	7
Sodium	236	411
Iron	0.10	0.12
Manganese	less than 0.05	less than 0.05
Sulfate	54	40
Chloride	142	330
Fluoride	0.9	0.5
Nitrate	less than 0.4	less than 0.4

The city of Victoria uses water from the Catahoula-Oakville-Lagarto formation overlapped by the Goliad-Willis-Lissie formation. About 3,980 acre-feet were obtained from these sources during 1958. Samples from eight of Victoria's wells, ranging in depth from 414 to 1,064 feet collected in 1951, 1952, and 1953, showed the following quality:

Analysis	Concentration (ppm)	
	414 Ft. Deep	1,064 Ft. Deep
Total Solids	508	665
pH	8.3	8.3
Alkalinity	300	295
Silica	24	17
Hardness	150	99
Calcium	40	28
Magnesium	12	7
Sodium	140	226
Iron	0.3	0.05
Manganese	less than 0.05	less than 0.05
Sulfate	18	57
Chloride	96	167
Fluoride	0.4	0.6
Nitrate	less than 0.4	less than 0.4

Subarea 7

Subarea 7 is an adjoining area that has small amounts of fair quality water in Beaumont clays, and considerable amounts in the Goliad-Willis-Lissie.

Subarea 8

Small amounts of fair quality ground water are available in Subarea 8 from the Beaumont clays.

Port Lavaca used about 810 acre-feet of the above water during 1958. Samples of water from two wells (depth 220 to 242 feet) collected in 1948 showed the following quality:

Analysis	Concentration (ppm)	
	220 Ft. Deep	242 Ft. Deep
Total Solids	1,957	793
pH	7.7	8.1
Alkalinity	315	383
Silica	20	22
Hardness	368	193
Calcium	98	41
Magnesium	30	22
Sodium	647	250
Iron	0.20	0.38
Manganese	less than 0.05	less than 0.05
Sulfate	6	61
Chloride	1,030	206
Fluoride	1.2	0.5
Nitrate	3.5	less than 0.4

STATEMENT OF THE TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE GUADALUPE, MISSION, AND LAVACA-NAVIDAD RIVER BASINS*

Guadalupe

Total Number of Sample Stations = 14
Total Number of Samples Taken = 698
Average Samples/Station = 49

Total Samples "Good" ---------------------------- 654 for 94%
Total Samples "Poor" Organically and Chemically --- 2
Total Samples "Poor" Organically Only ------------- 12 for 2%
Total Samples "Poor" Chemically Only -------------- 30 for 4%

Remarks: The results of the Sampling Program indicate excellent water quality conditions generally with the station on the F.M. Highway 1322 bridge east of Luling on Plum Creek accounting for 100% of the "Poor Chemically" samples of the entire basin.

Mission

Total Number of Sample Stations = 6
Total Number of Samples Taken = 360
Average Samples/Station = 60

Total Samples "Good" ---------------------------- 43 for 12%
Total Samples "Poor" Organically and Chemically -- 174 for 48%
Total Samples "Poor" Organically Only ------------ 16 for 5%
Total Samples "Poor" Chemically Only ------------- 127 for 35%

Remarks: The Mission River Basin has water of generally poor quality due primarily to oil field wastes and the general sluggish nature of the drainage area, some of which is subject to tidal action. This is reflected in the relatively small number of samples (only 12%), which were within the quality limits of the Survey.

Lavaca - Navidad

Total Number of Sample Stations = 4
Total Number of Samples Taken = 191
Average Samples/Station = 48

Total Samples "Good" ----------------------------	169 for 88%
Total Samples "Poor" Organically and Chemically ---	0
Total Samples "Poor" Organically Only -------------	16 for 8%
Total Samples "Poor" Chemically Only --------------	6 for 4%

Remarks: For the purpose of the Survey, these two River Basins were included into one basin designated as the Lavaca. The single sample station on the Navidad disclosed water quality consistently within the Survey limits with the exception of only one sample which was 0.5 ppm in excess of the Chlorine Demand limit. The three sample stations on the Lavaca indicated satisfactory water quality conditions with only occasional slight excesses chemically and organically.

*Presented to the U. S. Study Commission - Texas, June 6, 1960

TABLE G-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE GUADALUPE RIVER BASIN

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1	Guadalupe River	436	276	288	1941-49	---	---	---
	Johnson Creek	J5 G426	115	289	1941-	---	---	---
	Guadalupe River	425	---	---	---	---	8	1957-60
	Guadalupe River	400	762	290	1918-32	---	---	---
2	Guadalupe River	397	836	291	1939-	---	7	1957-60
	Guadalupe River	334	1,282	292	1922-	1942-45	---	---
4	Guadalupe River	281	1,516	293	1927-	---	---	---
	Comal River	C1 G280	Springs 117	294	1927- Supplemental records from 1882	---	21	1957-60
	Guadalupe River	279	1,624	295	1915-27	---	6	---
	Guadalupe River	256	---	---	---	---	5	---

Table G-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3	Blanco River	B35	364	298	1924-26 1928-	---	22	1957-60
	Blanco River	B13 SM74	424	299	1956-	---	---	---
	San Marcos River	SM77	---	---	---	---	19	1957-60
	San Marcos River	SM76	---	296 297	1956- 1915-21 Supplemental records for 1894-1906 & from 1921	---	---	---
	San Marcos River	SM34 G176	833	300	1939-	---	18	---
	Plum Creek	P19	---	301	1925-30	---	---	---
	Plum Creek	P7 SM26	356	302	1930-	---	20	1957-60
	San Marcos River	SM22 G176	---	303	1915-43	---	---	---
	San Marcos River	SM3	---	---	---	---	17	1957-60
	Guadalupe River	171	---	---	---	---	4	1957-60

Table G-2 (Continued)

Area	Stream	River Mile	Drainage Area	U. S. G. S.			TDH Quality	
				Discharge		Quality		
				Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
5	Peach Creek	P-11 G148	---	304	1930-33	---	---	---
	Sandies Creek	S20 G105	---	305	1930-34	---	---	---
6	Guadalupe River	103	---	---	---	---	3	1957-60
	Guadalupe River	51	5,161	307	1934-	1945-46 1948-57	2	1957-60
	Coleto Creek	C22	365	308	1930-33 1952-	---	---	---
	Coleto Creek	C12 G36	---	309	1939-54			
	Guadalupe River	8	---	---	---	---	1	1957-60

TABLE G-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE GUADALUPE RIVER BASIN

Gua-1	Refugio County	Bridge, State Hwy. 35 NE Tivoli
Gua-2	Victoria County	Bridge, U. S. Hwy. 59 in Victoria (No. 11)
Gua-3	DeWitt County	Bridge, F. M. 236 S Cuero
Gua-4	Gonzales County	Bridge, U. S. Hwy. 183 S Gonzales
Gua-5	Guadalupe County	Bridge, F. M. 466 SE Seguin
Gua-6	Comal County	Bridge, U. S. Hwy. 81 at New Braunfels
Gua-7	Kendall County	Bridge, U. S. Hwy. 87 at Comfort (No. 2)
Gua-8	Kerr County	Bridge, State Hwy. 39 at Ingram
Gua-9 through Gua-16 are in the San Antonio River Basin.		
Gua-17	Gonzales County	Bridge, San Marcos River, U. S. Hwy. 90-A Gonzales W
Gua-18	Caldwell County	Bridge, San Marcos River, State Hwy. 80 S Luling (No. 9)
Gua-19	Hays County	Bridge, San Marcos River, U. S. Hwy. 81 at San Marcos
Gua-20	Caldwell County	Bridge, Plum Creek, F. M. 1322 E Luling (No. 10)
Gua-21	Comal County	Bridge, Comal River, San Antonio Street viaduct in New Braunfels (No. 5)
Gua-22	Hays County	Bridge, Blanco River, F. M. 12 at Wimberley (No. 7)

Table G-2a (Continued)

Lavaca River Basin

Lav-1	Jackson County	Bridge, F. M. 616 between Vanderbilt and Lolita
Lav-2	Jackson County	Bridge, U. S. Hwy. 59 SW Edna (No. 2)
Lav-3	Lavaca County	Bridge, U. S. Hwy. 77 in Hallettsville (No. 1)
Lav-4	Jackson County	Bridge, Navidad River, U. S. Hwy. 59 SW Ganado (No. 3)

Mission River Area

Mis-1	Refugio County	Mission River at point on end of County Road just off F. M. 136 and immediately E of Bonnie View Oil Field
Mis-2	Refugio County	Bridge, Mission River, U. S. Hwy. 77 at Refugio (No. 1)
Mis-3	Refugio County	Bridge, Aransas Pass, U. S. Hwy. 77 SW Refugio
Mis-4	San Patricio County	Bridge, Chiltipin Creek, U. S. Hwy. 77 at Sinton
Mis-5	San Patricio County	North end of F. M. 1068 at Chiltipin Creek in Plymouth Oil Field
Mis-6	Bee County	Bridge, Poesta Creek, State Hwy. 202 SE Beeville

TABLE G-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL IN THE GUADALUPE RIVER BASIN

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
Subarea 1									
SOUTH FORK									
NORTH FORK	G436								
JOHNSON CREEK	G426								
Kerrville	G419	13,500	Wells	1.5	7,000	Land Irr.	594	375	458
Subarea 2									
Comfort	G398	860	Wells	.091	400	Land Irr.	880	540	888
Subarea 4									
COMAL CREEK	G280								
New Braunfels	G280	17,000	Wells	3.3	7,000	Guadalupe R.	350	335	---
Marion	G266	600	Well	.07	360	St. Clara Cr.	712	---	---
Seguin	G257	16,000	Guadalupe	1.7	5,650	Guadalupe R.	---	---	---

TABLE G-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
SAN MARCOS RIVER									
Subarea 3									
San Marcos	SM 79 G179	18,000	Wells	2.0	5,000	San Marcos R.	365	327	---
BLANCO RIVER	SM 76								
Martindale	SM 68	500	Well	.065	---	---	560	---	---
Staples	SM 63	150	Well	.075	---	---	---	---	---
Fentress	SM 54	300	San Marcos	.03	---	---	---	---	---
Luling	SM 36	5,000	4 Wells	0.559	4,297	San Marcos R.	1,220	1,110	---
PLUM CREEK									
Kyle	P44	1,000	2 Wells	0.31	---	---	700	470	---
Buda	P34	480	Well	0.21	---	---	---	---	---
Lockhart	P27	7,100	Well Springs	0.5	4,000	Town Branch	705	386	---
PLUM CREEK	SM26								

TABLE G-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
SAN MARCOS RIVER	G176								
Gonzales	G172	5,900	Guadalupe River	0.70	4,780	Guadalupe R.	---	---	---
Subarea 5									
PEACH CREEK	G148								
SANDIES CREEK	G105								
Smiley	S46	700	Well	---	---	---	---	---	---
Subarea 6									
Cuero	G104	8,500	7 Wells	0.752	6,340	Guadalupe Ri.	1,058	680	---
Victoria	G51	43,014	Wells	9.00	18,800	Guadalupe Ri.	665	472	490
COLETO CREEK	G36								
Yorktown	C58	2,600	Wells	0.2	2,000	Yorktown Creek	637	635	---
SAN ANTONIO RIVER	G11								

TABLE G-4

SALINE GROUND WATERS IN THE GUADALUPE RIVER BASIN

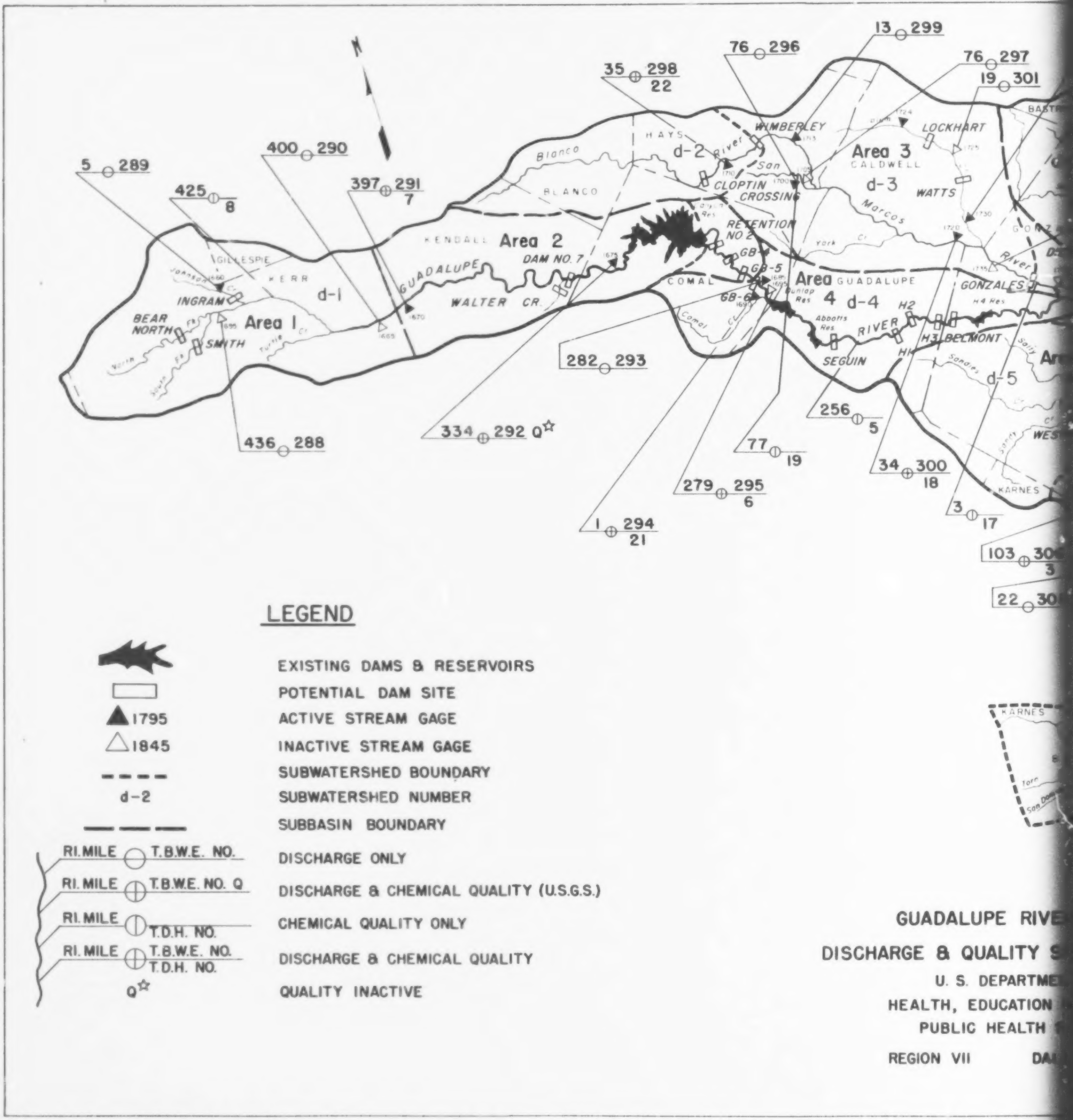
Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2	K1	Comal	237	560	1,350	Travis Peak Formation	S	---	Guadalupe
	K2	Comal	870	41	1,560	Travis Peak Formation	S,D	---	Guadalupe
	K23	Comal	1,380	17	2,370	Glen Rose Limestone	S,D	---	Guadalupe
	K24	Comal	2,200	10	> 2,210	Glen Rose Limestone	D	---	Guadalupe
	K50	Kendall	688	13	1,210	Trinity Group	S,D	---	Guadalupe
	K82	Comal	349	233	1,130	Edwards Limestone	---	---	Guadalupe
3	K83	Hays	324	208	1,040	Edwards Limestone	S	---	San Marcos
	K84	Hays	2,720	3,280	9,400	Edwards Limestone	S	---	San Marcos
	E2	Caldwell	212	222	1,390	Wilcox Group	Ind.	80	San Marcos (Luling)

*D, domestic; S, stock; Ind, industrial; Irr, irrigation; P, public supply; N, none.

TABLE G-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water *	Temp. °F	Nearest Stream
3 (continued)	E3	Caldwell	227	170	1,100	Wilcox Group	P	---	San Marcos (Luling)
	E39	Caldwell	1,100	700	>1,800	Carrizo Sand	D	71½	Land
6	M-15	DeWitt	1.1	334	1,070	Lagarto clay, Catahoula and Oakville sandstone	P	91	Guadalupe at Cuero
7	B-7	Calhoun	75	1,120	2,380	Beaumont clay, Alta Loma sand	D	---	Bay
	B-76	Calhoun	1.1	65	151	Loma sand	D	---	Bay
	B-8	Calhoun	19	1,140	2,060	Loma sand	---	---	Bay
10	M-16	Lavaca	41	910	1,900	Lagarto clay Catahoula and Oakville sandstone	---	---	Navidad River
12	B-6	Aransas	28	495	1,310	Beaumont clay, Alta Loma sand	D	---	Bay

A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Area 1
Area 2
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GUADALUPE
DAM NO. 7
WALTER CR.
WIMBERLEY
CLOPTIN CROSSING
RETENTION NO 2
GB-4
GB-5
GB-6
LOCKHART
WATTS
GONZALES
SEGUIN
BELMONT
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279 295 6
1 294 21
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103 30 3
22 30
LEGEND
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POTENTIAL DAM SITE
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1845 INACTIVE STREAM GAGE
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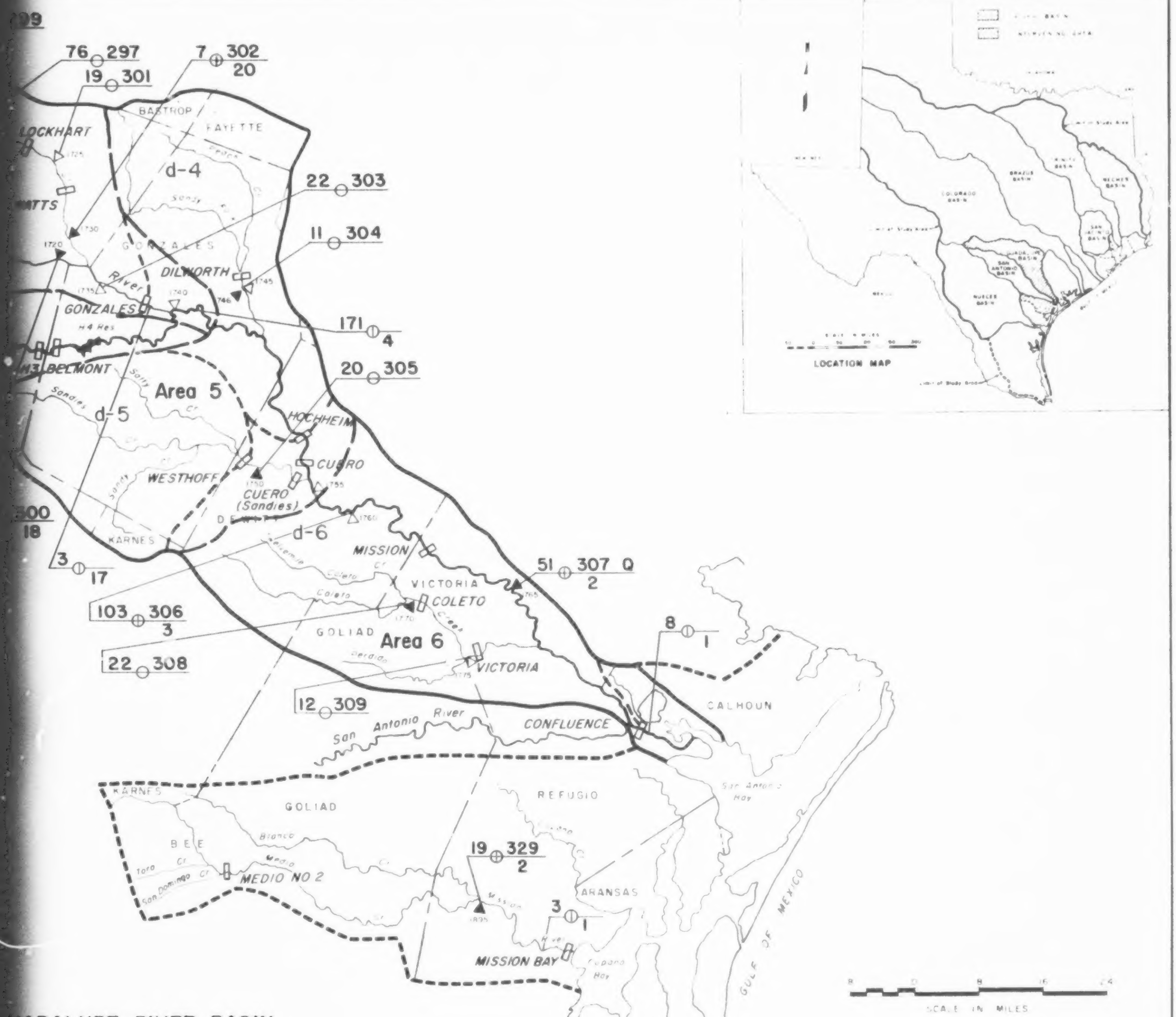
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SAN JACINTO BASIN
GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
Limit of Study Area
LOCATION MAP

UADALUPE RIVER BASIN

E & QUALITY SAMPLING STATIONS

U. S. DEPARTMENT OF
LTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
ON VII DALLAS, TEXAS

GUADALUPE RIVER BASIN

FIGURE NO. G-1

NECHES RIVER BASIN

Present Quality of Water Resources in the Neches River Basin

Section, or Subarea	Page
Physical Description	165
2A	166
2B	167
2C	168
2D	169
1A	170
1C	171
1B	172
1D	172
Statement of Texas Department of Health	

Physical Description

Geography

The Neches River Basin is contained entirely within the State of Texas. It rises in Van Zandt County and flows about 416 miles to its terminus in Sabine Lake. The principal tributary is the Angelina River, which is about 205 miles long, drains an area of about 950 square miles, and joins the Neches River at mile 126. The total drainage area of the Neches River is 9,995 square miles. It is bounded by the Sabine River Basin on the east and the Trinity River Basin on the west.

Topography

The topography of the Neches River Basin ranges from hilly in the upper portion, to gently rolling in the middle portion, and flat in the coastal area.

Rainfall-Runoff

The average annual rainfall increases from about 40 inches in the upper reaches of the basin to about 53 inches at the mouth of the river. The average annual runoff in acre-feet for the period 1940-56 was 5,873,273.

Impoundments

There are five major impoundments having a total capacity of 4,235,860 acre-feet and over 27,000 minor impoundments have a total capacity of 82,000 acre-feet. The latter are constructed for various purposes including municipal, industrial, irrigation, mining, and recreation.

TABLE NE-1

NECHES RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM

(As shown on Figure Ne-1)

2A. Neches River from mile 415 to mile 274.

2B. Neches River from mile 274 to mile 160.

1A. Neches River from mile 160 to mile 52.
    2C. Angelina River Headwaters.
    2D. Angelina River from mile An-113 to mouth
        (discharges to Neches River at mile 126).

1B. Neches River from mile 52 to mile 29.

1C. Village Creek Headwaters.
    Village Creek discharges to Neches River at mile 39.
    Pine Island Bayou discharges to Neches River at mile 30.

1D. Neches River from mile 29 to Sabine Lake.
    Taylor Bayou discharges to Sabine Lake.

Present Quality of Surface and Ground Water Sources In Subareas of Neches River Basin

Subarea 2A

The Neches River rises in Subarea 2A in Van Zandt County and flows 141 miles before passing into Subarea 2B. Traveling downstream, the following features may have some quality significance: Butler Creek (joins Neches at mile 380 and contains 50 per cent of Tyler's sewage effluent), Kickapoo Creek, Flat Creek, the city of Reese, Hurricane Creek, Dales Creek (with Gum Creek Reservoir and the city of Jacksonville in its headwaters), and San Pedro Creek. This subarea covers about 1,943 square miles.

A quality monitoring station located at mile 385 indicates excellent quality water at this point; total dissolved solids ranged from 52 to 276 ppm (median 156). At mile 333, the farthest upstream gaging station, the average flow for the water year 1957-58 was 1,103 cfs. The State Quality Monitoring station at that point showed a range of total solids from 81 to 357.

Ground waters in Subarea 2A are obtained from the Carrizo-Wilcox formation. Cities obtaining ground waters from this formation in Subarea 2A include Jacksonville, Palestine, and Rusk.

Palestine is the largest consumer of this water, and analysis of its supply is here listed to indicate the quality of water in Subarea 2A. Analysis of samples from three wells (1,600 feet deep) collected in 1953 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	132-230
pH	8.3-8.5
Total Alkalinity	40-175
Silica	4- 20
Total Hardness	19- 73
Calcium	5- 16
Magnesium	1- 8
Sodium	17- 82
Iron	0.12-0.17
Sulfate	7- 38
Chloride	7- 21
Fluoride	0.1-0.2

This analysis shows the water of Palestine to be of very good quality. Palestine used about 1,760 acre-feet of this water during 1958.

Subarea 2B

The Neches River flows from mile 274 to mile 160 in Subarea 2B. Traveling downstream, the following items occur: Larrison Creek, Cochino Bayou, Cedar Creek, Balaxy Creek (with Lufkin in its headwaters), and Piney Creek. Subarea 2B covers about 1,595 square miles. At mile 274, the average discharge during water year 1957-58 was 1,711 cfs. The quality is still good at this station, judging from the total solids recorded at the State Quality Monitoring station at this river mile -- they ranged from 63 to 324. The flow at mile 204 was 2,451 cfs with quality similar to the upstream station. At mile 158 the average discharge was 3,358 cfs. A U. S. Geological Survey quality station operated from 1941-42 and from 1945-47 showed a total dissolved solids of only 84 to 168 ppm, with an average of 118 ppm.

Ground water in Subarea 2B as indicated by information on the vicinity of Lufkin is obtained from the Carrizo-Wilcox formation.

Lufkin used about 2,080 acre-feet of water from the Carrizo-Wilcox formation during 1958. Samples collected from four wells (depth 112 to 1,221 feet) in 1953 had the following quality:

Analysis	Concentration (ppm)
Total Solids	368-450
pH	8.5-8.9
Total Alkalinity	200-265
Silica	13- 25
Total Hardness	26- 35
Calcium	7- 9
Magnesium	2- 3
Sodium	145-170
Iron	0.02-0.6
Sulfate	73- 91
Chloride	14- 25
Fluoride	0.2-0.4

These analyses show the water supply of Lufkin to be good except for a slightly high pH.

Subarea 2C

Subarea 2C is the headwaters of the Angelina River Basin which is formed by the confluence of Mud Creek and Striker Creek. The farthest upstream water records are for Lake Tyler, a 43,400 acre-feet impoundment that is used for the municipal supply of the ciy of Tyler to supplement Tyler's well water source. Analyses made in September, 1953, show the water from Lake Tyler to have 90 ppm total solids, a hardness of only 48 ppm, chlorides 18 ppm, and sulfates 11 ppm. This record indicates excellent water quality.

At mile 149 on the Angelina River, the discharge during water year 1957-58 was 2,096 cfs. A State Quality Monitoring station at that point showed total solids ranging from 69 to 186 ppm.

Ground waters available in Subarea 2C include Sparta, Queen City, and Carrizo-Wilcox sands. Cities drawing from ground water include Henderson and Tyler.

Henderson used 1,200 acre-feet of water from the Wilcox sands only during 1958. Samples collected from six wells (depth 560 feet to 740 feet) from 1947 to 1954 had the following quality:

Analysis	Concentration (ppm)
Total Solids	192-510
pH	7.9-8.6
Total Alkalinity	143-430
Silica	12- 14
Total Hardness	7- 42
Calcium	1- 12
Magnesium	1- 7
Sodium	68-210
Iron	0.08-0.70
Sulfate	4- 15
Chloride	14- 36
Fluoride	0.3-0.7
Nitrate	1.30

The city of Tyler also obtains its water from the Wilcox group.

Subarea 2D

Subarea 2D is the lower half of the Angelina River and includes the site of McGee Bend Reservoir. At mile 110, the discharge during water year 1957-58 was 2,096 cfs. The quality corresponding to this discharge at mile 110 is excellent: dissolved solids only 79 ppm; hardness 26 ppm; chlorides 18 ppm; and sulfates 14 ppm.

At mile 51 the main discharge was 3,564 cfs. It should be noted that the Southland Paper Mill pumps about 22 cfs from wells, of which about 18 cfs is later discharged into Mill Creek, 20 miles above this station. The town of Nacogdoches discharges about 2 cfs sewage effluent into La Nana Bayou, 27 miles above the station. This discharge is continuous and fairly constant. A State Quality Monitoring station at this point shows total solids to range from 75 to 204 ppm, chlorides from 20 to 52 ppm, sulfates from 17 to 30 ppm, and BOD from .5 to 5.2 ppm.

Attoyac Bayou discharged about 735 cfs (1957-58), containing total solids ranging from 34 to 198 ppm, to the Angelina at mile 54.

A discharge gage was operated from 1928-51 at mile 20 on the Angelina. Average discharge for this period of record was 3,280 cfs. A State Quality Monitoring station at that point showed total solids with a range from 46 to 220 ppm (median 115); chlorides with a range from 12 to 52 ppm (median 28); sulfates from 8 to 32 ppm (median 18); and BOD from .5 to 4.4 ppm. This is the last station on the Angelina prior to its discharge to the Neches River at mile 126.

Ground waters are obtainable from the Carrizo-Wilcox sands in Subarea 2D. Nacogdoches used 1,440 acre-feet of this water during 1958. Samples of water collected from two wells of Nacogdoches (depth 490 feet and 521 feet) during 1947-49 had the following quality:

Analysis	Concentration (ppm)
Total Solids	158-180
pH	7.2-7.7
Alkalinity	95-105
Silica	10- 13
Total Hardness	18
Calcium	4
Magnesium	2
Sodium	57- 60
Iron	0.45-0.5
Sulfate	24
Chloride	14- 16
Fluoride	0.1

Subarea 1A

The Neches River flows from mile 160 to mile 52 in Subarea 1A. Its incremental drainage area is about 850 square miles.

At mile 158, the average discharge for water year 1957-58 was 3,358 cfs; the total dissolved solids, as measured during 1941-42 and 1945-47 averaged 118 ppm.

Dam B, a 94,200 acre-feet (normal storage) impoundment is located at mile 114. It was completed in June, 1951, and is used for industrial, municipal, and irrigation supplies. During water year 1957-58, the average discharge one-half mile downstream from the dam was 7,931 cfs; total dissolved solids ranged from 62 to 167 ppm; chlorides from 14 to 36 ppm; and sulfates from 8 to 31 ppm.

Fifty-nine miles downstream from Dam B, at mile 55, the average discharge was 8,465 cfs, and the quality was still excellent as the Neches flowed from Subarea 1A to Subarea 1C.

	Max.	Min.	Avg.
Total Dissolved Solids	138	35	83 ppm
Chlorides	38	6	19 ppm
Sulfate	28	8.4	16 ppm
Hardness	46	14	27 ppm

Ground waters in Subarea 1A as indicated by the information for the vicinity of Jasper are obtained from the Catahoula-Oakville-Lagarto formation, with sands 200 to 300 feet thick. Samples collected from three Jasper wells (depth 580 feet to 634 feet) in 1951 had the following quality:

Analysis	Concentration (ppm)
Total Solids	128-140
pH	7.1-7.7
Total Alkalinity	30
Silica	63- 79
Total Hardness	28- 35
Calcium	8- 10
Magnesium	2- 3
Sodium	10- 17
Iron	1.6-12.0
Sulfate	11- 19
Chlorides	7- 11
Fluoride	0.1-0.2

Except for the high concentration of iron and silica in two samples, this water is of excellent quality.

Subarea 1C

Subarea 1C includes the Neches River from mile 52 to mile 29 and the lower portion of Village Creek as well as all of the Pine Island Bayou watershed.

There are no discharge gages in the Pine Island Bayou watershed. The quality at mile 1, as shown in the records for the State Quality Monitoring station there, indicate total solids ranging from 98 to 235 ppm; chlorides from 28 to 112 ppm; sulfates from 1 to 21 ppm; and BOD from .5 to 4.1 ppm.

Ground waters in Subarea 1C are obtained from a complex of overlapping aquifers and 600 feet of sand: Catahoula-Oakville-Lagarto and Goliad-Willis-Lissie, with possible some from Beaumont. W. O. George lists the following quality for this water:(III-2)

Analysis	Concentration (ppm)
Dissolved Solids	211
Sodium	17
Chloride	15

The cities of Kountze and Silsbee obtain their waters from this source.

Subarea 1B

Subarea 1B is the Village Creek watershed. A discharge gage at mile 24 on Village Creek recorded an average discharge of 967 cfs during water year 1957-58. A State Quality Monitoring station at mile 13 showed total solids ranging from 43 to 144 ppm. This represents the quality and discharge of the Village Creek water entering the Neches River at mile 40.

Ground water in Subarea 1B as indicated by information for the vicinity of Woodville is from sands of the Lagarto clay or Oakville sandstone. The quality of water from a 400 foot deep well of Woodville was:

Analysis	Concentration (ppm)
Total Solids	184
pH	6.9
Total Alkalinity	95
Silica	50
Total Hardness	115
Calcium	36
Magnesium	6
Sodium	14
Iron	0.32
Sulfate	11
Chloride	28
Fluoride	0.6

These analyses indicate a water supply of very good quality.

Subarea 1D

Subarea 1D includes the Neches River from mile 29 to its mouth in Sabine Lake. This is the tidewater portion of the Neches as reflected in the quality monitoring station results at miles 23 and 4. At mile 23, the total solids ranged from 86 to 5,400 and at mile 4, from 195 to 8,700 ppm. Median chlorides at mile 23 were about 30 ppm as compared with about 1,000 ppm at mile 4.

W. O. George has the following to say about the quality of waters in Subarea 1D:(III-2) "Beaumont now uses surface waters. Has drilled well ten miles north of city. Depths 804 feet, yield 4,530 gpm, drawdown 100 feet after 40 hours....Bottom 200 feet above salt water; salt water also two miles downdip. Additional wells planned to supply north side of city. Can develop 150,000 acre-feet per year within twenty miles north of city. Dissolved solids 504 ppm; chlorides 25 ppm; sodium 37 ppm.

Groves, Port Neches, Nederlands are in the salt water area.

STATEMENT OF THE TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE NECHES RIVER BASIN*

Total Number of Sample Stations = 17
Total Number of Samples Taken = 818
Average Samples/Station = 48

Total Samples "Good" ------------------------------	645 for 79%
Total Samples "Poor" Organically and Chemically ---	32 for 4%
Total Samples "Poor" Organically Only ------------	135 for 16%
Total Samples "Poor" Chemically Only -------------	6 for 1%

Remarks: From these results it might be inferred that whereas the water quality of the Neches River Basin is generally very good, there is an indication that sources of organic contribution are more predominate than are sources of chemical contribution. Closer examination of the data reveals that the influence of the organic sources appear to be most noticeable in the lower reaches of the Angelina River in the southern portion of Angelina County and the northern portion of Jasper County. Another similar area is in the upper reaches of the Neches River in the northern part of Henderson County. These sample points account for about 55% of the "Poor" organically samples of the River Basin with the remainder being located in the lower reaches of the Neches River Basin system.

It is emphasized that these results do not necessarily indicate "gross" pollution, but are in general slightly in excess of the survey quality limits, particularly with regard to the Chlorine Demand limits.

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*Presented to the U. S. Study Commission - Texas, June 6, 1960.

TABLE Ne-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE NECHES RIVER BASIN

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2-A	Neches River	385	---	---	---	---	9	1957-60
	Neches River	349	851	59	1924-27	---	---	---
	Neches River	333	1,143	60	1939-	---	8	1957-60
2-B	Neches River	274	1,943	61	1944-	---	7	1957-60
	Neches River	204	2,714	62	1923-25, 1939-	---	6	1957-60
	Neches River	158.4	---	---	---	---	5	1957-60
	Neches River	158	3,623	63	1903-	1941-42, 1945-47	---	---
2-C	Striker Creek	S-6 Sh-8 An-153	148	64	1940-49	---	---	---
	Prairie Creek (Lake Tyler)		45.3	65	1949-	---	---	---
	Mud Creek	Mu-26	376	66	1939-	---	---	---

TABLE Ne-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2-C	Mud Creek	Mu-12 An-168	481	67	1924-27	---	--	---
	Angelina River	An-149 N-126	1,282	68	1940-49	---	16	1957-60
2-D	Angelina River	An-110	1,604	69	1923-34, 1939-	1954-57	15	1957-60
	Angelina River	An-90	---	--	---	---	14	1957-60
	Arenoso Creek	Ar-45 At-26	76	70	1938-40	---	--	---
	Attoyac Bayou	At-41 An-54	501	71	1924-25, 1939-54, 1955-	---	17	1957-60
	Angelina River	An-51	2,894	72	1951-	---	13	1957-60
	Ayish Bayou	Ay-62 An-26	17.2	73	1924-25	---	--	---
	Angelina River	An-20	3,435	74	1928-51	1941-47	12	1957-60
1-A	Neches River (at Dam B)	114	7,561	75	1951-	---	--	---
	Neches River	113.5	---	--	---	---	4	1957-60

TABLE Ne-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1-A	Neches River	113	7,561	76	1951-	---	--	---
	Neches River	55	7,923	77	1904-06, 1923-	1929-41, 1947-57	3	1957-60
1-B	Village Creek	V-24	857	78	1924-27, 1939-	1939-41	--	---
1-C	Village Creek	V-13	---	--	---	---	11	1957-60
	Village Creek	V-7 N-40	---	--	---	1939-47	--	---
	Pine Island Bayou	P-1 N-30	---	--	---	1939-41	10	1957-60
1-D	Neches River	23	---	--	---	1939-41	2	1957-60
	Neches River	4	---	--	---	---	1	1957-60

Table Ne-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE NECHES RIVER BASIN

Nec-1	Jefferson County	Bridge, State Hwy. 87
Nec-2	Jefferson County	Bridge, U.S. Hwy. 90 near Beaumont
Nec-3	Jasper County	Bridge, U.S. Hwy. 96 near Evadale (No. 12)
Nec-4	Tyler County	Below Dam B at Town Bluff (No. 11)
Nec-5	Tyler County	Bridge, U.S. Hwy. 69 near Rockland (No. 4)
Nec-6	Angelina County	Bridge, U.S. Hwy. 59 S Diboll (No. 3)
Nec-7	Cherokee County	Bridge, State Hwy. 21 near Alto (No. 2)
Nec-8	Anderson County	Bridge, U.S. Hwy. 79 E Palestine (No. 1)
Nec-9	Henderson County	Bridge, State Hwy. 31, NE Chandler
Nec-10	Jefferson County	Bridge, Pine Island Bayou, U. S. Hwy. 69 at Voth
Nec-11	Hardin County	Bridge, Village Creek, U.S. Hwy. 96 near Silsbee
Nec-12	Jasper County	Bridge, Angelina River, State Hwy. 63 NW Jasper
Nec-13	Angelina County	Bridge, Angelina River, State Hwy. 147 NE Zavala (No. 9)
Nec-14	Angelina County	Bridge, Angelina River, State Hwy. 103 NE Huntington
Nec-15	Angelina County	Bridge, Angelina River, U.S. Hwy. 59 N Lufkin (No. 7)
Nec-16	Nacogdoches County	Bridge, Angelina River, State Hwy. 21 W Douglas
Nec-17	Nacogdoches County	Bridge, Attoyac Bayou, State Hwy. 21 E Chireno (No. 8)

TABLE Ne-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL IN THE NECHES RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
NECHES									
TRIBUTARY									
SOUTH PRAIRIE CREEK									
TRIBUTARY									
KICKAPOO CREEK	378								
EAST FORK									
Subarea 2A									
Brownsboro	---	455	1 Well	0.02	---	---	---	---	---
TRIBUTARY									
WEST FORK									
SALINE CREEK									
KILLOUGH CREEK									

TABLE Ne-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
TRIBUTARY									
Frankston	---	1,132	1 Well	---	390	Caddo Creek to Neches River	116	95	---
BRUSHY CREEK									
WALNUT CREEK									
HURRICANE CREEK									
STILLS CREEK									
Palestine	---	16,000	4 Wells	1.75	15,000	Stills Creek	---	---	---
TAILS CREEK									
Jacksonville	T-21	10,560	Lake Acker & Lake Jacksonville	1.30	9,000	Tails Creek	420	80	---
IONI CREEK									
SAN PEDRO CREEK									
BOX CREEK	312								

TABLE Ne-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
TRIBUTARY	B14								
Rusk	T-8	4,200	2 Wells & lake	0.45	3,950	Trib. to Neches Ri.	487	95	---
BOWLES CREEK									
HICKORY CREEK									
LARRISON CREEK									
Alto	---	1,300	2 Wells	---	775	Larrison Cr. to Neches Ri.	655	636	---
BADANO BAYOU									
COCHING BAYOU									
LYNN CREEK									
ELM CREEK									
TRIBUTARY									
CEDAR CREEK									
Keltys	---	---	Lufkin	---	---	Lufkin, Tex.	---	---	---
ALABAMA CREEK	206								
STOVALL CREEK									

TABLE Ne-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 2B									
Lufkin	---	18,000	3 Wells	1.909	9,500	Hurricane Cr.	450	358	---
TRIBUTARY									
BEAR CREEK									
BALAXY CREEK									
Corrigan	---	1,600	2 Wells	0.15	660	Dry Creek to Neches River	290	---	---
CANEY CREEK									
RUSSELL CREEK	170								
SHAWNEE CREEK	166								
BILLAMS CREEK									
Rockland	158	---	---	---	---	---	---	---	---
CYPRESS CREEK									
Aldridge	147	---	---	---	---	---	---	---	---

TABLE Ne-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
TRIBUTARY									
Smith Ferry	138	---	---	---	---	---	---	---	---
ANGELINA RIVER	126								
MUD CREEK	An-168								
TRIBUTARY									
Subarea 2C									
Whitehouse	---	640	Wells	0.028		---	---	---	---
TRIBUTARY									
Arp	---	1,110	3 Wells	---	550	Kickapoo Creek	1,080	615	---
Troup	---	2,165	3 Wells	0.11	1,300	Caney Creek to Angelina Ri.	573	495	---
WEST MUD CREEK	AN-168								
Tyler	Wm-23	58,000	8 Wells Bellwood L. Taylor L.	7.60	50,000	Butler Creek	590	70	---
Bullard	---	475	1 Spring	---	---	---	86	---	---
TRIBUTARY									

TABLE Ne-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
TRIBUTARY									
TRIBUTARY									
COOKS CREEK									
EAST FORK									
Mount Enterprise	---	275	1 Well	0.057	---	---	---	---	---
Cushing	---	500	1 Well	0.070	340	E. Fork Tri. to Angelina Ri.	215	94	---
SHAWNEE CREEK	An-153								
Henderson	---	11,065	7 Wells	1.00	13,833	Shawnee Creek to Angelina Cr.	510	192	---
TRIBUTARY									
STRIKERS CREEK									
BOWLES CREEK									
TRIBUTARY									
TRIBUTARY									
LOCO BAYOU	An-121								

TABLE Ne-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
LITTLE LOCO BAYOU									
LA NANA BAYOU									
Appleby		90	1 Well	0.006	---	---	---	---	---
TRIBUTARY									
Subarea 2D									
Nacogdoches	---	14,150	5 Wells	1.39	6,000	La Nana Bayou	180	150	---
MILL CREEK									
CARIZZO CREEK									
TUSCOSSO CR.									
BISITADOR CREEK									
ATTOYAC BAYOU	An-54								
TRIBUTARY									
Timpson	---	1,700	2 Wells	---	815	Flat Fork Cr. to Sabine Ri.	788	780	---
Garrison	---	1,315	2 Wells	0.06	350	Attoyac Bayou to Angelina Ri.	421	415	---

TABLE Ne-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
NACONCHIO BAYOU	At-71								
HOOPER CREEK	At-69								
ARENOSO CREEK									
TRIBUTARY									
TRIBUTARY									
RAPHOR CREEK									
HARVEY CREEK									
CLEAR CREEK									
AYISH BAYOU	An-26								
Blandlake	Ay-67								
San Augustine	Ay-62	2,500	2 Wells	0.304	2,510	Ayish Bayou to Angelina River	980	878	---
Macune	Ay-47	---	---	---	---	---	---	---	---
TRIBUTARY									
SANDY CREEK									
BEAR CREEK	Ay-7								

TABLE Ne-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
DEVILS FORK									
Pineland	---	1,600	2 Wells	0.36	---	Devils Fork	---	---	---
INDIAN CREEK									
WOLF CREEK									
CAMP CREEK									
SANDY CREEK	114								
Subarea 1A									
Jasper	---	6,000	4 Wells	0.653	2,820	Sandy Creek	143	128	
BIG CREEK									
WRIGHT CREEK									
TRIBUTARY									
TRIBUTARY									
BOGGY CREEK									
MILL CREEK									
Evadale	54	---	---	---	---	---	---	---	---

TABLE Ne-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
VILLAGE CREEK									
BEAR CREEK									
DOUBLE BAYOU									
SHOAL CREEK									
WOODS CREEK									
TURKEY CREEK									
Subarea 1B									
Doucette	---	100	1 Well	0.01	---	---	---	---	---
Woodville	---	2,300	3 Wells	0.21	1,600	Town Branch	184	---	---
CYPRESS CREEK									
BEECH CREEK									
THEUVENINS CREEK									
Subarea 1C									
Silsbee	---	5,000	2 Wells	0.65	710	Village Creek	187	170	---
PINE ISLAND BAYOU	30								

TABLE Ne-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
TRIBUTARY									
Saratoga	---	600	3 Wells	---	---	---	---	---	---
BARISTE CREEK									
Hull (includes Daisetta)		4,000	3 Wells	---	---	---	---	---	---
TRIBUTARY									
CYPRESS CREEK									
WILLOW									
CYPRESS CREEK									
Honey Island	---	900	1 Well	0.20	--	---	442	---	---
Kountze	---	2,000	2 Wells	0.125	1,500	Creek to Neches River	230	208	---
TENNILE CREEK									
Subarea 1D									
Beaumont	21	116,000	Neches River	11.99	90,000	Neches River	156	150	---
TRIBUTARY									
Vidor	---	2,500	1 Well	0.25	---	---	---	---	---

TABLE Ne-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
Port Neches	6	8,500	Neches River	0.588	5,000	Tidewater	---	---	---
Port Arthur	On Sabine Lake	78,000	Neches River	6.00	60,000	Sabine Lake (tidewater)	167	---	---
TAYLOR BAYOU	Trib. of Sabine L.								
TRIBUTARY									
NORTH FORK									
TRIBUTARY									
Amelia	---	---	Beaumont	---	---	---	---	---	---
TRIBUTARY									
Nederland	---	8,000	Neches River	0.529	2,000	Small Creek to Neches Ri.	---	---	---
SALT BAYOU									
Sabine Pass	---	---	Port Arthur, Texas		---	---	---	---	---
GULF OF MEXICO									

TABLE Ne-4

SALINE GROUND WATERS IN THE NECHES RIVER BASIN

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2B	E43	Angelina	4	858	2,320	Carrizo Sand	N	---	Neches Ri.
	E44	Angelina	360	140	1,090	Carrizo Sand	S	---	Neches Ri.
	E64	Angelina	91	920	>1,000	Sparta Sand	P	---	Neches Ri.
	E73	Angelina	210	250	1,170	Claiborne Group	---	---	Neches Ri.
	E74	Angelina	609	375	1,870	Claiborne Group	---	---	Neches Ri.
	E84	Angelina	460	211	1,460	Jackson Group	Ind.	---	Neches Ri.
2C	E10	Cherokee	0.0	88	1,470	Wilcox Group	---	---	Neches Ri.
2D	E53	Angelina	1	1,400	>1,000	Queen City Sand	Ind.	---	Angelina River

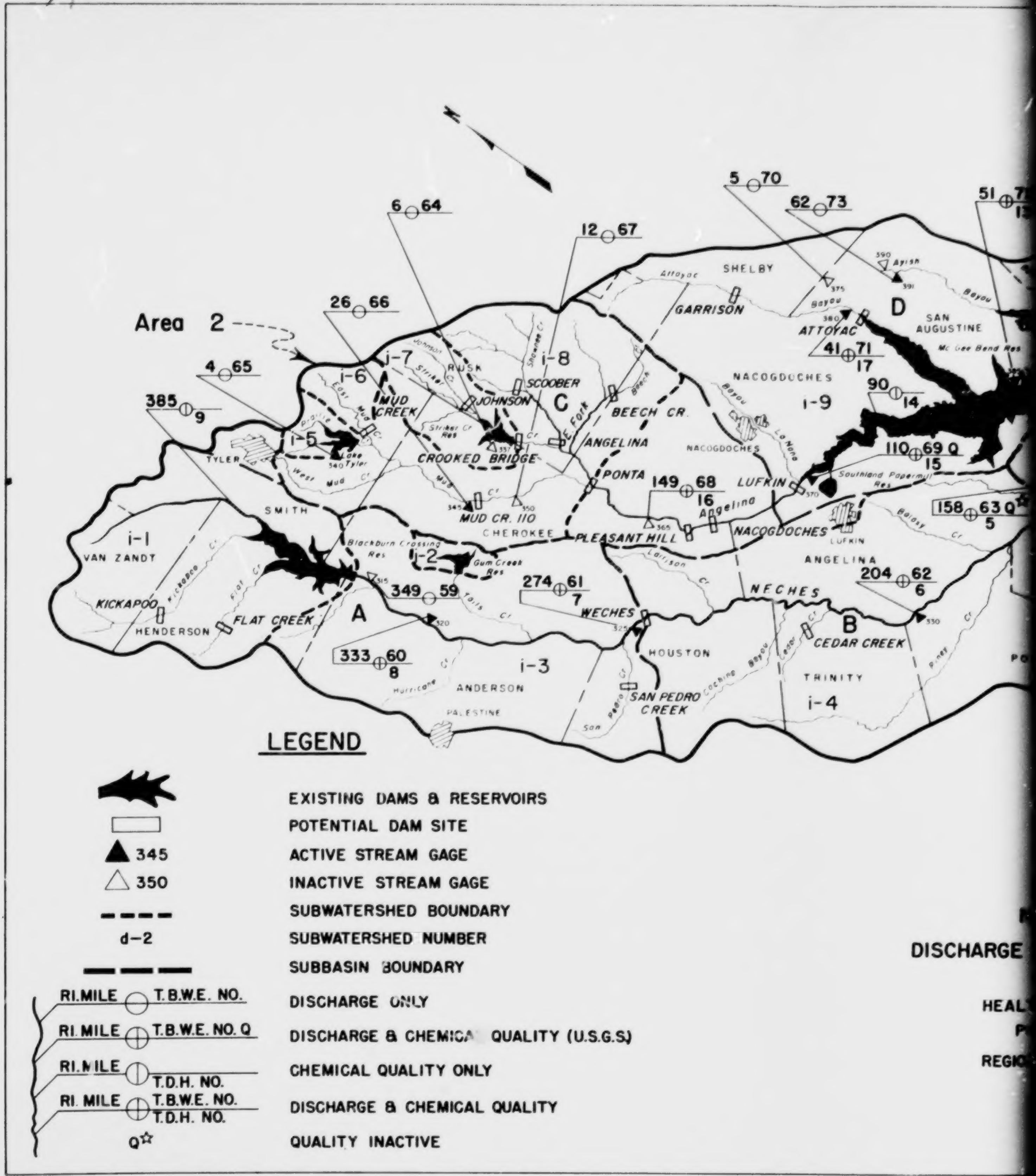
*D, domestic; S, stock; Ind, industrial; Irr, irrigation; P, public supply; N, none.

TABLE Ne-4 (Continued)

SALINE GROUND WATERS IN THE NECHES RIVER BASIN

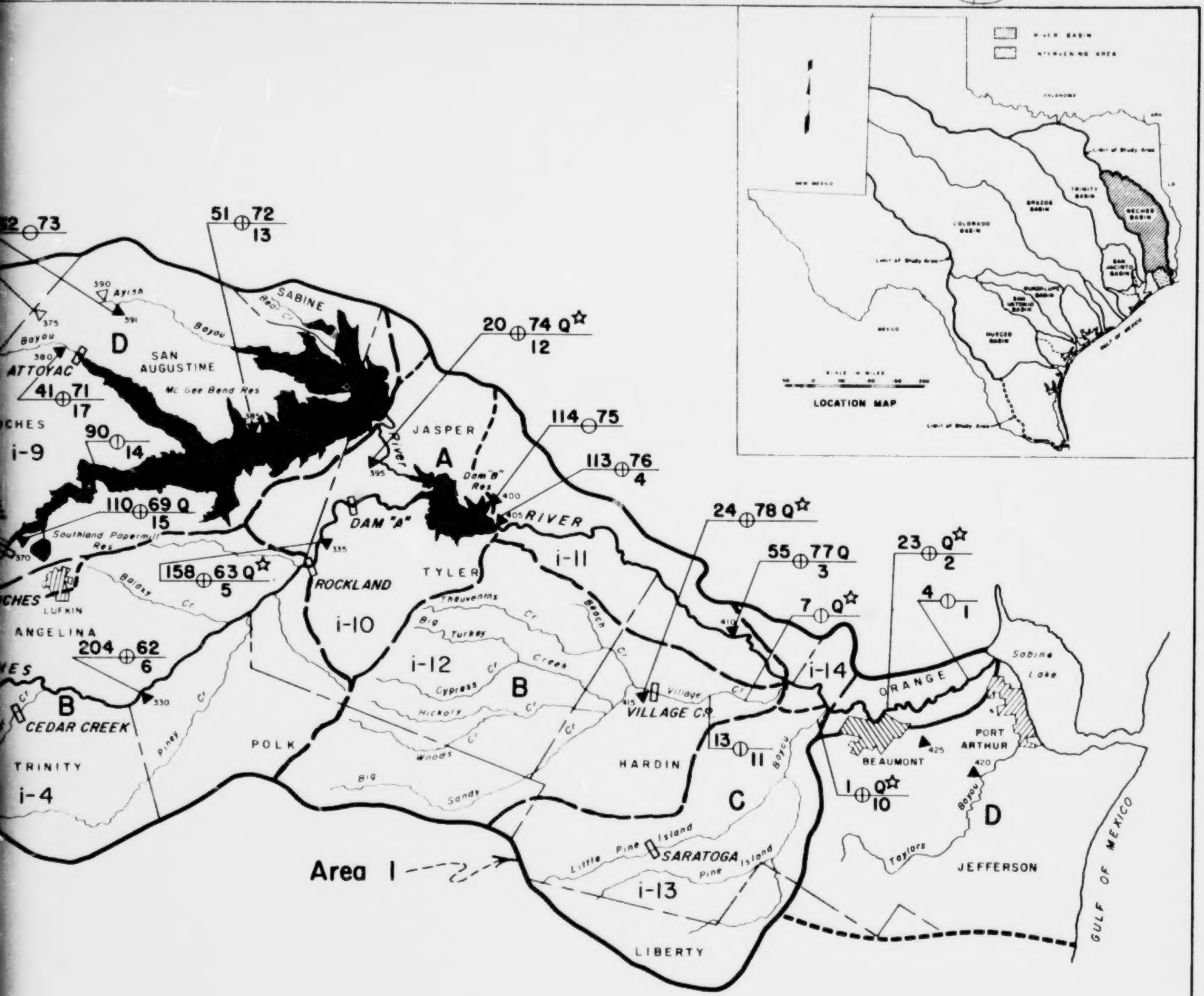
Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1A	E75	Jasper	1	3,060	5,450	Claiborne Group	S	65	Angelina River
	E76	Jasper	9.8	8,700	15,100	Claiborne Group	---	---	Neches River
	E77	Jasper	604	41	1,320	Claiborne Group	---	---	Neches River
1C	0-64	Hardin	5	330	1,180	Goliad Sand, etc.	---	---	Pine Island Bayou
1D	0-62	Jefferson	2	2,590	4,510	Goliad Sand, etc.	Ind.	---	Neches River
	B-22	Jefferson	2	935	1,820	Beaumont Clay	N	---	Tri. to Neches River

A


Area 2
i-1
i-2
i-3
i-4
i-5
i-6
i-7
i-8
i-9
A
B
C
D
VAN ZANDT
HENDERSON
SMITH
TYLER
CHEROKEE
RUSK
ANDERSON
PALESTINE
HOUSTON
TRINITY
ANGELINA
NACOGDOCHES
LUFKIN
SHELBY
SAN AUGUSTINE
KICKAPOO
FLAT CREEK
MUD CREEK
CROOKED BRIDGE
MUD CR. 110
JOHNSON
SCOOBER
BEECH CR.
E. Fork ANGELINA
PONTA
PLEASANT HILL
WECHES
SAN PEDRO CREEK
CEDAR CREEK
NECHES
GARRISON
ATTOYAC
NACOGDOCHES
Lake Tyler
Blackburn Crossing Res
Gum Creek Res
Southland Papermill Res
Mc Gee Bend Res
385 9
4 65
26 66
6 64
12 67
5 70
62 73
51 71 13
41 71 17
90 14
110 69 Q 15
149 68 16
158 63 Q 5
204 62 6
274 61 7
349 59
333 60 8
LEGEND
EXISTING DAMS & RESERVOIRS
POTENTIAL DAM SITE
345 ACTIVE STREAM GAGE
350 INACTIVE STREAM GAGE
SUBWATERSHED BOUNDARY
d-2 SUBWATERSHED NUMBER
SUBBASIN BOUNDARY
RI. MILE T.B.W.E. NO. DISCHARGE ONLY
RI. MILE T.B.W.E. NO. Q DISCHARGE & CHEMICAL QUALITY (U.S.G.S.)
RI. MILE T.D.H. NO. CHEMICAL QUALITY ONLY
RI. MILE T.B.W.E. NO. T.D.H. NO. DISCHARGE & CHEMICAL QUALITY
Q☆ QUALITY INACTIVE
DISCHARGE
HEAL
P
REGIO

U.S. STUDY COMMISSION TEXAS NE 55

192 B



52 73
51 72 13
20 74 Q 12
114 75
113 76 4
110 69 Q 15
90 14
41 71 17
158 63 Q 5
204 62 6
24 78 Q
55 77 Q 3
23 Q 2
7 Q
4 1
13 11
1 Q 10
D
SAN AUGUSTINE
ATTOYAC
Ayish
Bayou
SABINE
Mc Gee Bend Res
JASPER
A
Dam "B" Res
DAM "A"
RIVER
ROCKLAND
Southland Papermill Res
LUFKIN
ANGELINA
i-9
i-10
i-11
i-12
i-13
i-14
i-4
TYLER
B
CEDAR CREEK
TRINITY
POLK
HARDIN
VILLAGE CR.
C
SARATOGA
Little Pine Island
Pine Island
Big Sandy
Hickory
Cypress
Big Turkey Creek
Theuvenins
Beech Cr
Village Cr
Woods
Piney Cr
Bayou
LIBERTY
ORANGE
BEAUMONT
PORT ARTHUR
Sabine Lake
Taylors Bayou
D
JEFFERSON
GULF OF MEXICO
Area 1
370
375
380
390
391
395
400
405
410
415
420
425
330
335
RIVER BASIN
INTERVENING AREA
OKLAHOMA
NEW MEXICO
MEXICO
NECHES BASIN
TRINITY BASIN
BRAZOS BASIN
COLORADO BASIN
SAN JACINTO BASIN
GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
GULF OF MEXICO
Limit of Study Area
LA
LOCATION MAP
SCALE IN MILES

8 0 8 16 24
SCALE IN MILES

NECHES RIVER BASIN

DISCHARGE & QUALITY SAMPLING STATIONS

U. S. DEPARTMENT OF

HEALTH, EDUCATION & WELFARE

PUBLIC HEALTH SERVICE

REGION VII DALLAS, TEXAS

NECHES RIVER BASIN

FIGURE NO. Ne-1

NUECES RIVER BASIN

Present Quality of Water Resources in the Nueces River Basin

Section, or Subarea	Page
Physical Description	193
1A	194
1C	195
1F	196
1B	196
1E	197
1D	198
2A	199
2B-C	200
Statement of Texas Department of Health	201

Physical Description

Geography

The Nueces River Basin lies entirely within southeastern Texas, with its southern boundary roughly parallel to, and 10-35 miles from, the Rio Grande. It has a total length along the main channel of the river of approximately 450 miles. It is bounded on the north by the Colorado River Basin, on the east-northeast by the San Antonio River Basin, and on the east-southeast by the Gulf of Mexico. The basin has an air line length of 235 miles and a maximum air line width of 115 miles. Its drainage area is approximately 16,900 square miles.

Topography

The Basin lies within two distinct physiographic regions with one, the upper area, being the Edwards Plateau section and the other, the lower area, being the West Gulf Coastal Plains section. The physical change between these two sections of the Basin is clearly marked by the Balcones Escarpment as it crosses the Basin from central Kenedy County to the central part of Medina County, or from river mile 250 to river mile 210. The river drops about a thousand feet as it passes through these 40 miles of rough canyons.

Rainfall-Runoff

The Nueces River Basin has a relatively mild climate, with occasional extremes in temperature, humidity, and wind. Average annual rainfall varies from about 30 inches along the northeastern side of the Basin to about 20 inches along the southwestern side of the Basin. The runoff varies greatly as is indicated by the stream gaging station farthest downstream at Mathis. At this station, the maximum flow was 49,400 cfs and occurred on July 12, 1942, while a minimum of 6.8 cfs occurred on August 15, 1940. For the sixteen years of record, the average discharge was 814 cfs.

TABLE NU-1

NUECES RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure Nu-1)

1A. Nueces River from mile 446 to mile 362.

1C. Nueces River from mile 362 to mile 240.

1F. Nueces River from mile 240 to mile 104.
Subarea 1F also includes six miles of the Frio River.
  1E. Frio River joins Nueces River at mile 103.
    1D. Atascosa River joins Frio River at mile F-6.
      1B. Headwaters join Frio River Basin.

2A. Nueces River from mile 104 to mile 46.

2B-2C. Nueces River from mile 46 to mouth is boundary between areas 2B and 2C.

2B. Adjoining area (Aransas River) discharges to Copan Bay.

2C. Adjoining area (Aqua Dulce, etc.) discharges to Baffin Bay.

Present Quality of Surface and Ground Waters In Subareas of Nueces River Basin

Subarea 1A

Subarea 1A is the headwaters of the Nueces River Basin. The Nueces River travels from its origin at about mile 446 to mile 362 where it passes to Subarea 1C. Subarea 1A covers approximately 1,947 square miles. The farthest upstream discharge gage and corresponding State Quality Monitoring station are at mile 395. The discharge during water year 1957-58 averaged 308 cfs. Total solids varied from 217 to 342 ppm; chlorides varied from 8 to 24 ppm; and sulfates varied from 6 to 20 ppm. There are many small diversions above this station for irrigation. At mile 382 on the West Nueces River, the discharge was 237 cfs. In ordinary years, most of the run-off on the West Nueces Basin is lost by seepage into Edwards limestone above this station.

At mile 366 the discharge was 449 cfs during 1957-58. The 19-year period of record showed an average discharge somewhat less, 70.8 cfs. The Balcones Fault Zone crosses the Basin just north of Uvalde. At low stages most of the headwater flow enters Edwards limestone formation. There are many small diversions above this station for irrigation. The quality monitoring station at mile 360 showed a range of total solids from 200 to 540 ppm; chlorides from 15 to 48 ppm; and sulfates from 5 to 106 ppm. This represents the quality of water passing from Subarea 1A to Subarea 1C.

Subarea 1A is primarily a recharge area for Edwards and associated limestones reservoir.

Subarea 1C

The Nueces River travels 122 miles, from mile 362 to mile 240, in this 3,313 square mile subarea. A discharge gage and quality monitoring station are located at mile 288. The average discharge during water year 1957-58 was 505 cfs. The flow at this point is slightly regulated by several small reservoirs above this station. There are many diversions above this station for irrigation. Total solids varied from 146 to 348 ppm. Thus, the quality of water in the Nueces River as it passes from Subarea 1C to 1F is well within the adopted criteria.

Ground waters in Subarea 1C are obtained from the Carrizo-Wilcox formation and the Edwards limestone. The cities that obtain their water from the Carrizo include Carrizo Springs and Crystal City. Carrizo Springs used 510 acre-feet and Crystal City used 740 acre-feet during 1958. Samples collected from two wells of Crystal City (depth 1,050 feet and 990 feet) in 1945 had the following quality:

Analysis	Concentration (ppm)
Dissolved Solids	420-430
Total Hardness	238
Silica	19- 20
Iron	.28-.45
Calcium	64
Magnesium	19
Sodium	61- 60
Bicarbonate	296-293
Sulfate	64
Chloride	43
Fluoride	0.2
Nitrate	0.4

Subarea 1F

The Nueces River travels 136 miles through this subarea from mile 240 to mile 104, draining an area of 3,329 square miles. This subarea also includes six miles of the Frio River, which joins the Nueces as the latter passes from Subarea 1F to Subarea 2A. At mile 236 the average discharge during 1957-58 was 496 cfs. The previous 33-year period of record showed an average cf 272 cfs. Most of the low flow is diverted above this station by pumping for irrigation. Total solids ranged from 129 to 684 ppm -- median was about 300 ppm; chlorides ranged from 4 to 132 ppm; sulfates from 11 to 102 ppm.

At mile 141 the average discharge was 845 cfs during 1957-58 as compared with 385 cfs for the period 1943-57. There is no quality monitoring station at mile 141. A quality monitoring station at mile 114 shows total solids ranging from 129 to 1,404 ppm. The increase in total solids is apparently due to chlorides, since the range of chlorides was from 8 to 480 ppm. Sulfates ranged from 15 to 119 ppm. The median values were still within the adopted criteria limits being about 400 ppm total solids and about 80 ppm chlorides. This represents the quality of water passing from Subarea 1E to Subarea 2A.

Subarea 1B

Subarea 1B is the headwaters of the Frio River. This subarea covers 3,493 square miles and includes the subtributaries Leona River, Blanco River, Sabinal River, and Hondo Creek. At mile 224 the discharge during water year 1957-58 was 213 cfs. A quality monitoring station at this point showed good quality water with total solids ranging from 252 to 351 ppm. Dry Frio Creek discharged about 101 cfs to the Frio River at mile 204. There is no quality data available on the Dry Frio Creek.

At mile 199.7 the average discharge was 93.7 cfs. Many irrigation diversions are used above this station.

The Sabinal River discharged about 173 cfs to the Frio River at mile 172.

Hondo Creek discharged approximately 159 cfs of which 67 cfs came from Seco Creek, which joins the Hondo Creek about four miles before its confluence with the Frio River at mile 144.

A quality monitoring station at mile 128 showed the water to have a range of total solids from 141 to 483 ppm.

Ground waters in Subarea 1B are obtained primarily from the Edwards limestone.

The cities of Hondo and Uvalde obtain their supplies from the Edwards limestone. Hondo used 560 acre-feet during 1958, and Uvalde used 2,210 acre-feet. Analysis of waters from eight wells (depth 140 feet to 525 feet) sampled from 1945 to 1952 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	283-363
pH	7.0-8.2
Total Alkalinity	210-255
Silica	11- 19
Total Hardness	224-332
Calcium	75-113
Magnesium	7- 12
Sodium	7- 17
Iron	0.03-0.92
Sulfate	10- 33
Chloride	18- 46
Fluoride	0.1-0.6
Nitrate	2.2- 9

The only quality deficiency of this supply is its hardness.

Subarea 1E

Subarea 1E includes the Frio River from mile 124 to mile 6. At mile 123 the discharge during water year 1957-58 was 338 cfs. The average discharge for the period of record from 1915-57 was somewhat less, 133 cfs. There is no quality data available for this station. At mile 43 total solids ranged from 168 to 852 ppm -- median 393; chlorides from 56 to 210 -- median 80 ppm; sulfates from 11 to 82 -- median 41 ppm. At mile 25 the total solids ranged from 162 to 1,128 with a median of 418; chlorides, from 8 to 360, median 76; and sulfates from 13 to 124, median 59 ppm. A gage at mile 22 showed an average discharge of 615 cfs for 1957-58 with a 26 year period of record of 243 cfs. The chemical quality corresponding to this discharge was recorded at mile 15: total solids ranged from 147 to 1,008 ppm, median 565; chlorides from 12 to 220 ppm, median about 90; sulfates from 12 to 175 ppm, median about 90. BOD at this station ranged from 0.5 to 4.3 ppm.

Ground waters in Subarea 1E are obtainable from the Carrizo-Wilcox formation and a small part of the Edwards limestone.

The city of Dilley used about 0.4 mgd of water from the Carrizo-Wilcox formation during 1958. Water from two wells (524 feet and 1,800 feet deep) sampled in 1952 and 1950 respectively showed the following quality:

Analysis	Concentration (ppm)
Total Solids	336-370
pH	8.1-7.8
Total Alkalinity	250-240
Silica	32- 24
Total Hardness	142-116
Calcium	37- 30
Magnesium	12- 10
Sodium	125- 95
Iron	2.4-1.8
Sulfate	94- 45
Chloride	46- 25
Fluoride	1.1-0.4
Nitrate	0.4-0.9

Except for being moderately hard and containing iron in excess of the recommended limit, this appears to be good quality water.

Subarea 1D

This is the Atascosa River watershed. A discharge gage at mile 13 showed an average flow during 1957-58 of 267 cfs. A 27 year period of record showed an average discharge of 134 cfs. Several artesian wells above this gage are allowed to flow into the river to supplement the supply of Corpus Christi. The State Quality Monitoring station No. 15 showed total solids at about mile 12 ranging from 153 to 1,330 ppm, with a median of about 1,065; chlorides from 20 to 260 ppm; and sulfates from 24 to 310 ppm. The Atascosa River joins the Frio River at mile 6, the junction of Subareas 1D, 1E, and 1F.

Ground waters in Subarea 1D are obtained mostly from the Carrizo-Wilcox sand. Cities that obtain their water from this source include Pleasanton and Jourdanton, the former using 550 acre-feet and the latter 210 acre-feet during 1958.

Analysis of water from one of the Pleasanton wells (815 feet deep) collected in 1953 showed the following quality:

Analysis	Concentration (ppm)
Total Solids	484
pH	8.0
Total Alkalinity	285
Silica	17
Total Hardness	47
Calcium	12
Magnesium	4
Sodium	188
Iron	.21
Sulfate	32
Chloride	96
Fluoride	0.3

This represents good quality water.

Subarea 2A

This subarea includes the Nueces River from mile 104 to mile 46. At mile 103 the average discharge during 1957-58 was 1,765 cfs. The preceding 40 year period of record showed an average discharge at this point of 780 cfs. State Quality Monitoring Station No. 4 at this point showed total solids ranging from 117 to 1,020 ppm, median 486; chlorides from 8 to 240 ppm, median about 80; sulfates from 13 to 170 ppm, median about 75.

Lake Corpus Christi was formed by the old Mathis Dam at mile 48 on the Nueces River. The Mathis Dam was completed and storage began July 24, 1934. Siltation surveys showed the original capacity to have been 54,000 acre-feet as of that date; 43,400 acre-feet as of March, 1942; and 39,400 acre-feet as of March, 1948. The Mathis Dam was abandoned April 25, 1958, and replaced by the Wesley E. Seale Dam, located about 1,500 feet downstream from the Mathis Dam. The capacity of the latter is about 185,900 acre-feet. Discharge at mile 48 averaged 1,538 cfs during water year 1957-58. This water contained about 31 ppm chlorides, 30 ppm sulfates, 115 ppm hardness, and 233 ppm dissolved solids (968 tons per day). This quality and discharge represents the water in the Nueces River as it passes from Subarea 2A into its farthest downstream section, the boundary between Subareas 2B and 2C.

Ground waters in Subarea 2A are available in the Catahoula-Oakville-Lagarto formation. The city of George West utilized 120 acre-feet of this water during 1958. Samples collected from two wells (500 and 504 feet deep) in September, 1952, had the following quality:

Analysis	Concentration (ppm)
Total Solids	1,310-1,185
pH	7.8-7.8
Total Alkalinity	300-290
Silica	45- 37
Total Hardness	270-233
Calcium	72- 57
Magnesium	22- 22
Sodium	371-327
Iron	0.28-3.8
Sulfate	353-290
Chloride	291-249
Fluoride	1.2-1.2

The above analyses show this water to be of unsatisfactory quality from the standpoint of total solids, total hardness, sodium, iron, sulfate, and chloride.

Subarea 2B-2C

State Quality Monitoring Station No. 1 located at mile 6 is the farthest downstream station on the Nueces River. Total solids ranged from 105 to 720 ppm, median 375; chlorides from 12 to 200 ppm, median about 68; sulfates from 26 to 57 ppm, median about 45; and BOD from 0.5 to 10.4 ppm, with 3 out of 23 samples with 4 ppm or greater.

The Nueces River discharges over 1,500 cfs of water having a quality within the limits of the adopted criteria to Corpus Christi Bay and thence to the Gulf.

Ground waters in Subarea 2B are generally deficient in quantity and of poor quality. Cities that utilize this ground water include Aransas Pass, Beeville, Gregory, Ingleside, Taft, Odem, Portland, Mathis, and Sinton. Of these cities, the largest consumer of ground water was Beeville, which used 1,370 acre-feet during 1958.

A composite of water from five wells (depth from 600 to 1,540 feet) as found in the distribution system in April, 1953, showed the following quality:

Analysis	Concentration (ppm)
Total Solids	1,392
pH	8.3
Alkalinity	485
Silica	28
Total Hardness	82
Calcium	18
Magnesium	9
Sodium	500
Iron	.2
Sulfate	19
Chloride	472
Fluoride	1.0

This water as shown in the preceding analysis contains excessive total solids, alkalinity, sodium, and chlorides.

STATEMENT OF THE TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE NUECES RIVER BASIN*

Total Number of Sample Stations = 16
Total Number of Samples Taken = 816
Average Samples/Station = 51

Total Samples "Good" ------------------------------	682 for 84%
Total Samples "Poor" Organically and Chemically ---	4
Total Samples "Poor" Organically Only -------------	32 for 4%
Total Samples "Poor" Chemically Only --------------	98 for 12%

Remarks: Generally good water quality conditions prevail in the Nueces River Basin. Samples from the Frio River in Live Oak and McMullen Counties and from the Atascosa River in Live Oak County near Whitsett account for 82% of the "Poor Chemically" results. Organic sources do not appear to be too evident as affecting water quality.

*Presented to the U. S. Study Commission - Texas, June 6, 1960.

TABLE Nu-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE NUECES RIVER BASIN

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1-A	Nueces River	395	764	330	1923-	---	9	1957-60
1-A	West Nueces River	N382	700	331	1939-50 1956-	---	---	---
1-A	Nueces River	372	1,930	332	1927-38	---	---	---
1-C	Nueces River	366	1,947	333	1939-	---	8	1957-60
1-C	Nueces River	322	2,150	334	1915-25	---	---	---
1-C	Nueces River	288	4,082	335	1939-	---	7	1957-60
1-F	Nueces River	236	5,260	336	1923-	---	6	1957-60
1-F	Nueces River	141	8,192	337	1942-	Dec. 1949	---	---
1-F	Nueces River	114	---	---	---	---	5	1957-60
1-B	Frio River of Nueces River	F224 Nu104	405	338	1923-29 1930-	---	14	1957-60
1-B	Dry Frio of Frio River	DF20± F204	117	339	1952-	---	---	---
1-B	Frio River	F199.7	661	340	1952-	---	---	---

Table Nu-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1-B	Sabinal River of Frio River	S31± F172	206	341	1942-	---	---	---
1-B	Sabinal River of Frio River	S16± F172	247	342	1952-	---	16	1957-60
1-B	Hondo Creek of Frio River	H50 F144	86.2	343	1952-	---	---	---
1-B	Hondo Creek of Frio River	H40 F144	132	344	1952-	---	---	---
1-B	Seco Creek of Hondo Creek of Frio River	Se50± H4 F144	53.2	345	1952-	---	---	---
1-B	Seco Creek of Hondo Creek of Frio River	Se43± H4 F144	87.4	346	1952-	---	---	---
1-B	Frio River	F170	1,460	347	1924-27	---	---	---
1-B	Frio River	F128	---	---	---	---	13	1957-60
1-B	Leona River of Frio River	L55± F124	Spring Flow	348	1939-	---	---	---

Table Nu-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1-B	Leona River of Frio River	L12 F124	556	349	1924-29	---	---	---
1-E	Frio River	F123	3,493	350	1915-	---	---	---
1-E	Frio River	F43	---	---	---	---	12	1957-60
1-E	Frio River	F25	---	---	---	---	11	1957-60
1-E	Frio River	F22	5,491	351	1924-26 1932-	---	---	---
1-E	Frio River	F15	---	---	---	---	10	1957-60
1-D	Atascosa River of Frio River	A35 F6	530	352	1951-	---	---	---
1-D	Atascosa River of Frio River	A13 F6	1,171	353	1924-26 1932-	---	---	---
1-D	Atascosa River	A12±	---	---	---	---	15	1957-60
2-A	Nueces River	Nu103	15,600	354	1915-	1945-46 1950-52	4	1957-60
2-A	Nueces River	59±	---	---	---	---	3	1957-60

Table Nu-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2A	Nueces River Lake Corpus Christi	48	16,656	355	1948-	1947-52	2	1957-60
2B-2C	Nueces River	47	16,660	356	1939-	---	---	---
2B-2C	Nueces River	6^{+}_{-}	---	---	---	---	1	1957-60

TABLE Nu-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE NUECES RIVER BASIN

Nue-1	Nueces County	Bridge, U. S. Hwy. 77 at Calallen
Nue-2	San Patricio County	Bridge, State Hwy. 359 SW Mathis (No. 22)
Nue-3	Live Oak County	Bridge, F. M. 534 at Dinero
Nue-4	Live Oak County	Bridge, U. S. Hwy 281 S Three Rivers (No. 20)
Nue-5	Live Oak County	Bridge, County road one mile N Simmon
Nue-6	LaSalle County	Bridge, U. S. Hwy. 181 at Cotulla (No. 5)
Nue-7	Dimmitt County	Bridge, F. M. 190 between Asherton and Brundage (No. 4)
Nue-8	Zavala County	Bridge, U. S. Hwy. 83 SW Uvalde (No. 3)
Nue-9	Uvalde County	Bridge, State Hwy. 55 S Laguna (No. 1)
Nue-10	Live Oak County	Bridge, Frio River, F. M. 63 at Three Rivers
Nue-11	McMullen County	Bridge, Frio River, F. M. 99 N Calliham (No. 18)
Nue-12	McMullen County	Bridge, Frio River, State Hwy. 173 at Tilden
Nue-13	Frio County	Bridge, Frio River, U. S. Hwy. 81 N Dilley (No. 17)
Nue-14	Uvalde County	Bridge, Frio River, State Hwy. 127 SE Concan (No. 7)
Nue-15	Live Oak County	Bridge, Atascosa River, F. M. 99 at Whitsett (No. 19)
Nue-16	Uvalde County	Bridge, Sabinal River, U. S. Hwy. 90 W Sabinal (No. 11)

TABLE Nu-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL IN THE NUECES RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 1A									
NUECES RIVER									
Camp Wood	416	800	1 Spring	0.1	---	---	---	---	---
Subarea 1C									
LaPryor	347	1,000	2 Wells	0.12	---	---	---	---	---
Crystal City	309	8,500	3 Wells	0.60	2,320	Arroyo Slough	---	---	---
TRIBUTARY	301								
Carrizo Springs		5,500	6 Wells	0.44	1,150	Carrizo Creek	---	---	---
ELMORO CREEK	228								
Asherton	---	1,575	1 Well	0.18	195	Small Creek	---	---	---
NEGRO CREEK	262								

TABLE Nu-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Big Wells	NC12	550	1 Deep Well	0.06	---	---	---	---	---
SAN ROGUE CREEK	258								
Catarina	SR12	200	1 Well	0.03	---	---	---	---	---
Subarea 1F									
Cotulla	236	4,200	4 Wells	0.60	2,500	Land Irr.	---	---	---
CAIMAN CREEK	196								
CHULARETO CREEK	CaC8								
Encinal	Chc16	500	1 Well	0.03	---	---	---	---	---
FRIO RIVER	104								
Subarea 1B									
Leaky	F242±	750	2 Wells	0.09	---	---	---	---	---
SABINAL RIVER	F172								
Sabinal	S16±	1,700	2 Deep Wells	0.36	1,700	Land Irr.	---	---	---
HONDO CREEK	F144								
Hondo	H32±	7,100	4 Wells	0.80	6,000	Land Irr.	---	---	---

TABLE Nu-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
SECO CREEK	H4								
D'Hanis	SC24	700	1 Well	0.058	---	---	---	---	---
BUCK CREEK	F128								
Pearsall	BC3	5,400	3 Deep Wells	0.54	1,100	Land (Broad irr.)	---	---	---
LEONA RIVER	F124								
Uvalde	L60	12,500	8 Wells	2.90	4,250	Lagoons, Land irr.	---	---	---
Subarea 1E									
Dilley	F118	2,250	2 Wells	0.40	600	Dry Draw	---	---	---
Tilden	---	400	1 Well	0.05	---	---	---	---	---
SAN MIGUEL CREEK	F31								
CHACAN CREEK	SM42								
Devine	CC24	3,000	5 Wells	0.15	400	Land Irr.	---	---	---
ATASCOSA RIVER	F6								
TRIBUTARY									

TABLE Nu-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 1D									
Lytle	---	850	1 Well	---	---	---	---	---	---
GALVAN CREEK									
North Pleasanton	---	900	2 Art. Wells	---	---	---	---	---	---
Pleasanton	A53±	3,200	3 Wells	0.30	1,200	Bonito Creek	---	---	---
Campbellton	A26	350	1 Well	0.045	---	---	---	---	---
LA PARITA CREEK	A17								
Charlotte	---	1,300	1 Well	---	150	Lagunious Cr.	---	---	---
METATE CREEK	LaP4								
Jourdanton	M20±	1,500	2 Wells	0.15	800	LaParita Creek Land Irr.	---	---	---
Subarea 2A									
Three Rivers	F4	2,700	Nueces River	0.35	1,000	Nueces River	---	---	---
TRIBUTARY of NUECES RIVER	90								

TABLE Nu-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Total Dissolved Solids in Source of Public System: Min. ppm	Total Dissolved Solids in Source of Public System: System ppm
George West	Cr.6	1,600	2 Wells	0.17	1,420	Tynan Hollow Cr.	---	---	---
TRIBUTARY of NUECES RIVER	46								
Subarea 2B									
Mathis	---	6,500	4 Wells	0.50	700	Land Irr.	---	---	---
Subarea 2C									
Corpus Christi	0	200,000	Nueces River and Lake	39.0	150,000	Bay	---	---	---

TABLE Nu-4

SALINE GROUND WATERS IN THE NUECES RIVER BASIN

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1B - Sabinal River	K17	Medina	1,500	18	2,260	Limestone	S	74	Sabinal River
Frio River	K18	Medina	2,900	27	4,100	Limestone	D, S	73	Ferde Creek
	K19	Medina	2,480	30	3,610	Limestone	D, S	---	Seco Creek
	K20	Medina	783	37	1,380	Limestone	S	--	Seco Creek
	K48	Medina	919	358	2,220	Trinity Group	--	---	Peer Creek
	K77	Uvalde	234	178	1,020	Edwards Limestone	P	---	Frio River
	K78	Medina	625	11	1,070	Edwards Limestone	D, S	---	Seco Creek
	E21	Medina	733	565	2,350	Indio Formation	D, S	---	Frio River
	22	Medina	229	322	1,290	Indio Formation	D, S	---	Hondo Creek

*D, domestic; S, stock; Ind, industrial; Irr, irrigation; P, public supply; N, none.

Table Nu-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1B (continued)	23	Medina	393	1,070	2,840	Indio Formation	S	76	Seco Creek
	24	Medina	81	312	1,150	Indio Formation	D, S	---	Chacan Creek
	25	Medina	15	1,290	2,840	Indio Formation	D, S	---	Chacan Creek
	55	Frio	177	282	1,020	Mount Selman Formation	D, S Irr.	76	Bude Creek
1C - Nueces River	E17	Dimmitt	385	169	1,280	Indio Formation	D, S	---	Creek
	18	Dimmitt	126	820	1,880	Indio Formation	S	---	Rocky Creek
	19	Dimmitt	1,750	460	3,570	Indio Formation	S	---	Pena Creek
	20	Savala	842	1,080	3,180	Indio	---	---	Chapariosa Creek

Table Nu-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1C (continued)	27	Dimmitt	1,610	2,350	6,400	Carrizo Sand	D, S	--	Elmoro Creek
	28	Dimmitt	956	3,460	7,430	Carrizo Sand	M	94	San Rogue Creek
	29	Dimmitt	402	795	2,150	Carrizo Sand	Irr.	--	Creek
	30	Dimmitt	212	378	1,170	Carrizo Sand	P	96	Creek
	45	Dimmitt	680	2,190	4,930	Bigford member of Mount Selman	---	---	Creek
	46	Dimmitt	4,070	3,420	11,800		---	---	Creek
1D - Atascosa River	E33	Atascosa	65	44	675	Carrizo Sand	P	138	Atascosa River
	34	Atascosa	129	322	2,010	Carrizo Sand	S	109½	Atascosa River
	35	Atascosa	760	570	2,190	Carrizo Sand	---	---	Atascosa River

Table Nu-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDs ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1D (continued)	48	Atascosa	1,330	435	2,980	Queen City Sand	---	---	Creek
	56	Atascosa	2,450	1,730	6,530	Mount Selman	---	---	La Parita
	57	Atascosa	894	660	2,690	Mount Selman	---	---	La Parita
	58	Atascosa	152	497	1,710	Mount Selman	P	---	La Parita
	59	Atascosa	169	850	3,060	Mount Selman	P	91	Atascosa River
1E - Nueces River	E36	La Salle	110	118	1,150	Carrizo Sand	---	---	Creek
Frio River	54	La Salle	192	422	2,360	Mount Selman	P	81	Frio River
	70	McMullen	8,680	1,020	>1,000	Claiborne Group	S	---	Miguel Creek
1F - Nueces	E31	La Salle	104	179	1,120	Carrizo Sand	Irr.	---	Chucarelo Creek
	32	McMullen	3	168	1,430	Carrizo Sand	---	---	Green Creek
	67	La Salle	1,830	1,650	5,820	Claiborne Group	---	---	Nueces River

Table Nu-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1F (Continued)	68	La Salle	589	385	1,720	Claiborne Group	---	---	Nueces River
	045	Webb	-----	950	>1,000	Goliad Sand	---	---	Creek
2A - Atascosa River	E81	Live Oak	819	1,110	3,430	Jackson Group	Ind.	---	Atascosa River
Nueces River	M10	Live Oak	316	267	1,230	Catahoula Sandstone	P	81	Nueces River
	055	Live Oak	2	638	1,320	Goliad Sand	Irr.	---	Nueces River
2B - Copano Bay	M11	Bee	1	480	1,350	Catahoula Sandstone	P	95	Paesta Creek
Nueces River	052	San Patricio	43	378	1,000	Goliad Sand	P	---	Nueces River
Aransas River	53	San Patricio	1	1,060	2,090	Goliad Sand	P	---	Chiltipin Creek
	54	San Patricio	1	1,340	2,590	Goliad Sand	P	---	Chiltipin Creek
	B3	San Patricio	58	1,310	2,700	Beaumont Clay	P	---	Chiltipin Creek

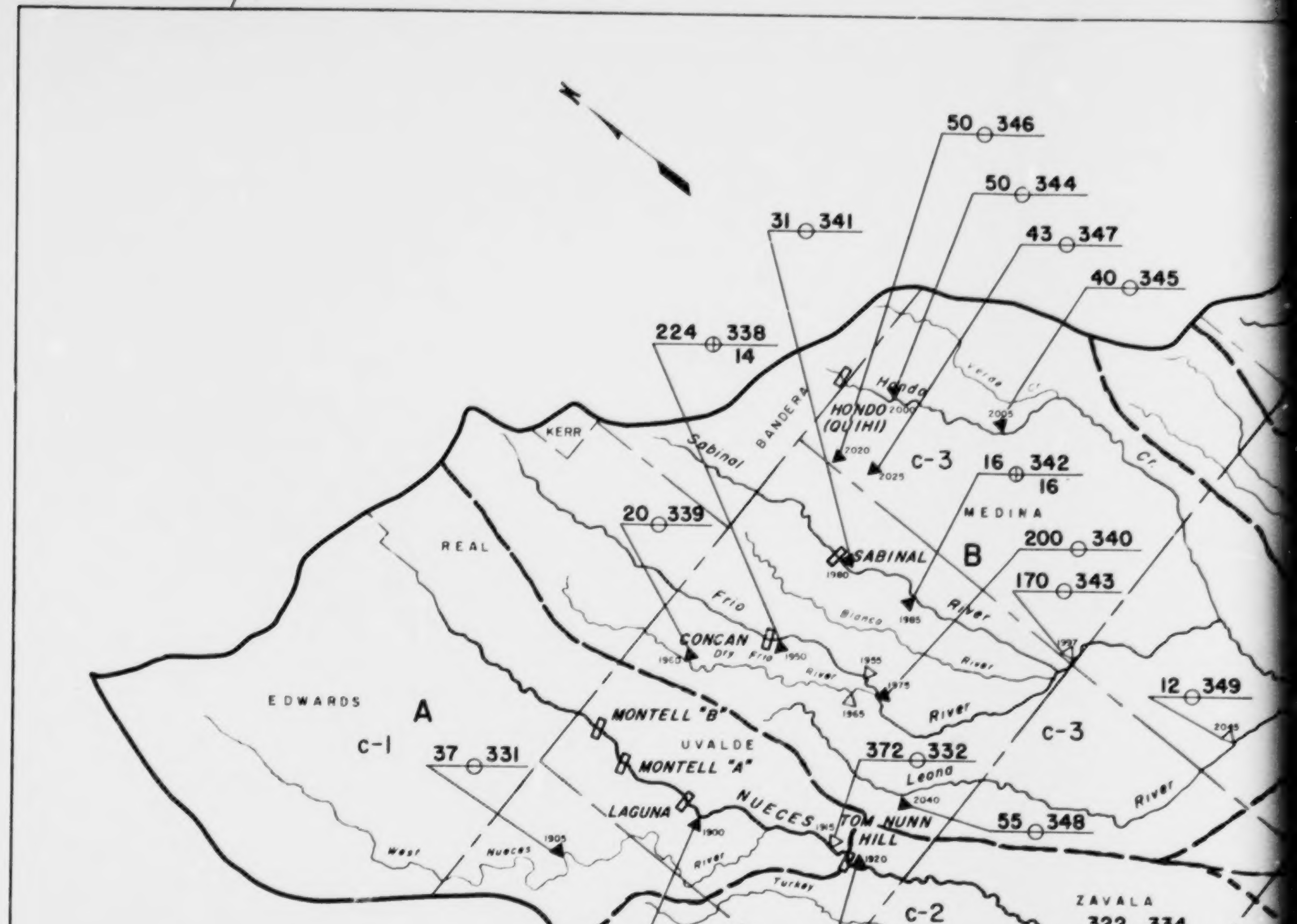
Table Nu-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2B (continued)									
Corpus Christi Bay	4	San Patricio	113	570	1,470	Beaumont Clay	P	---	Corpus Christi Bay
	5	San Patricio	66	508	1,330	Beaumont Clay	P	---	Corpus Christi Bay
2C - Nueces River	M6	Duval	7	2,510	4,440	Catahoula Sandstone	P	89	Nueces River
	7	Duval	191	1,320	2,810	Catahoula Sandstone	P	78	Nueces River
	8	Duval	8	2,520	4,460	Catahoula Sandstone	P	88½	Nueces River
	9	Duval	54	560	1,220	Catahoula Sandstone	D, S	---	Nueces River
Baffin Bay	044	Kleberg	270	278	1,110	Goliad Sand	P	85	Acero Creek
	46	Duval	75	515	1,180	Goliad Sand	D, S	---	San Diego Creek

Table Nu-4 (Continued)

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2C (continued)	47	Duval	231	338	1,200	Goliad Sand	P	80½	Los Animas Creek
	48	Jim Wells	128	289	1,020	Goliad Sand	P	86	San Diego Creek
	49	Jim Wells	180	495	1,320	Goliad Sand	---	---	Acero Creek
	50	Jim Wells	124	332	1,080	Goliad Sand	P	78½	Aqua Dulce Creek
	51	Nueces	249	390	1,370	Goliad Sand	---	---	Aqua Dulce Creek
	B2	Kleberg	627	4,640	8,410	Beaumont Clay	D, S	---	San Gertru is Creek

A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KERR
BANDERA
REAL
MEDINA
EDWARDS
UVALDE
ZAVALA
KINNEY
MAVERICK
HONDO (QUIHI)
SABINAL
CONCAN
MONTELL "B"
MONTELL "A"
LAGUNA
TOM NUNN HILL
CRYSTAL CITY
CAIMANCHE
NUECES
RIVER
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C
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LEGEND
EXISTING DAMS & RESERVOIRS
POTENTIAL DAM SITE
1920 ACTIVE STREAM GAGE
1955 INACTIVE STREAM GAGE
SUBWATERSHED BOUNDARY
d-2 SUBWATERSHED NUMBER
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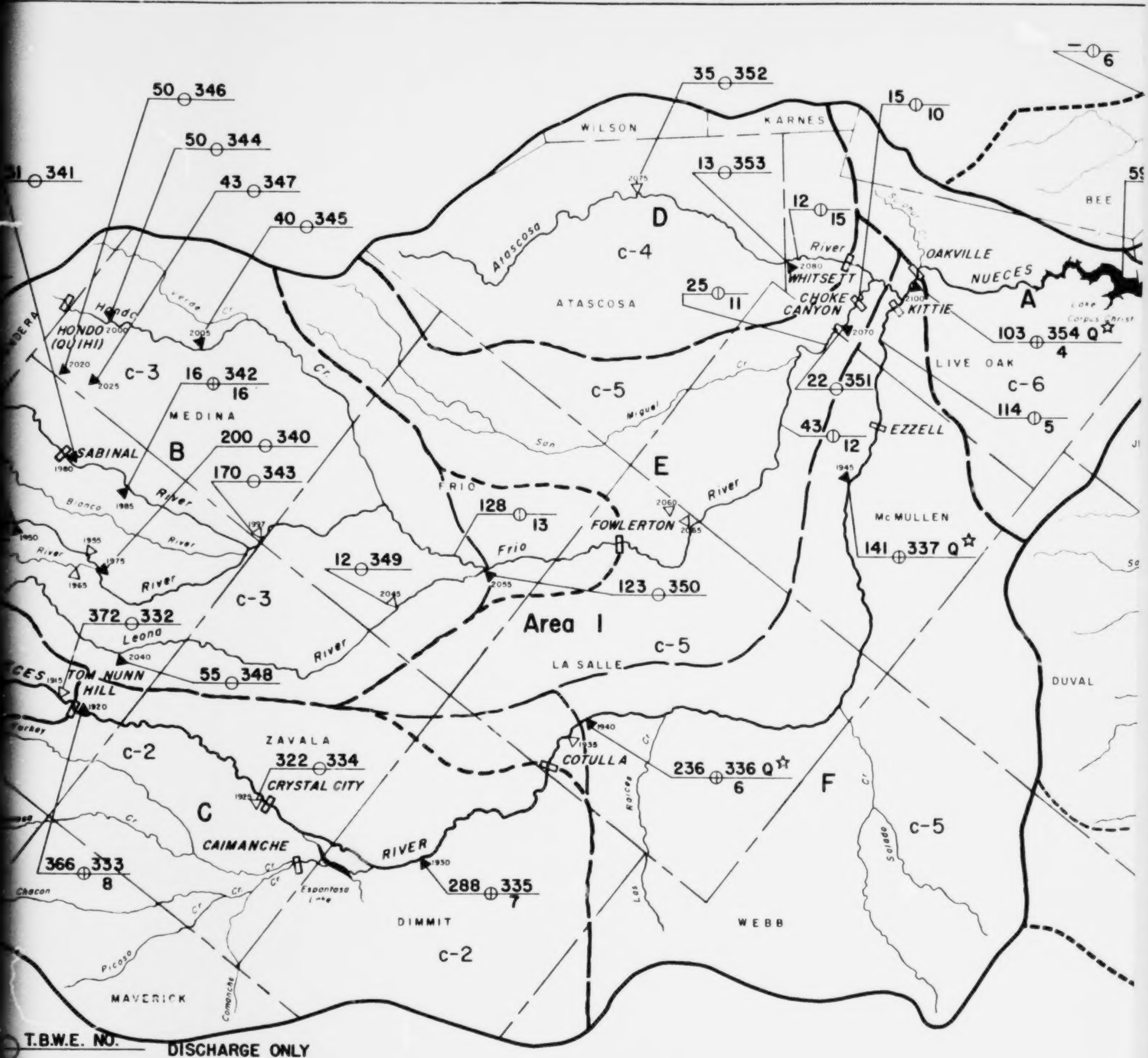

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T.D.H. NO. CHEMICAL QUALITY ONLY

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T.D.H. NO. DISCHARGE & CHEMICAL QUALITY

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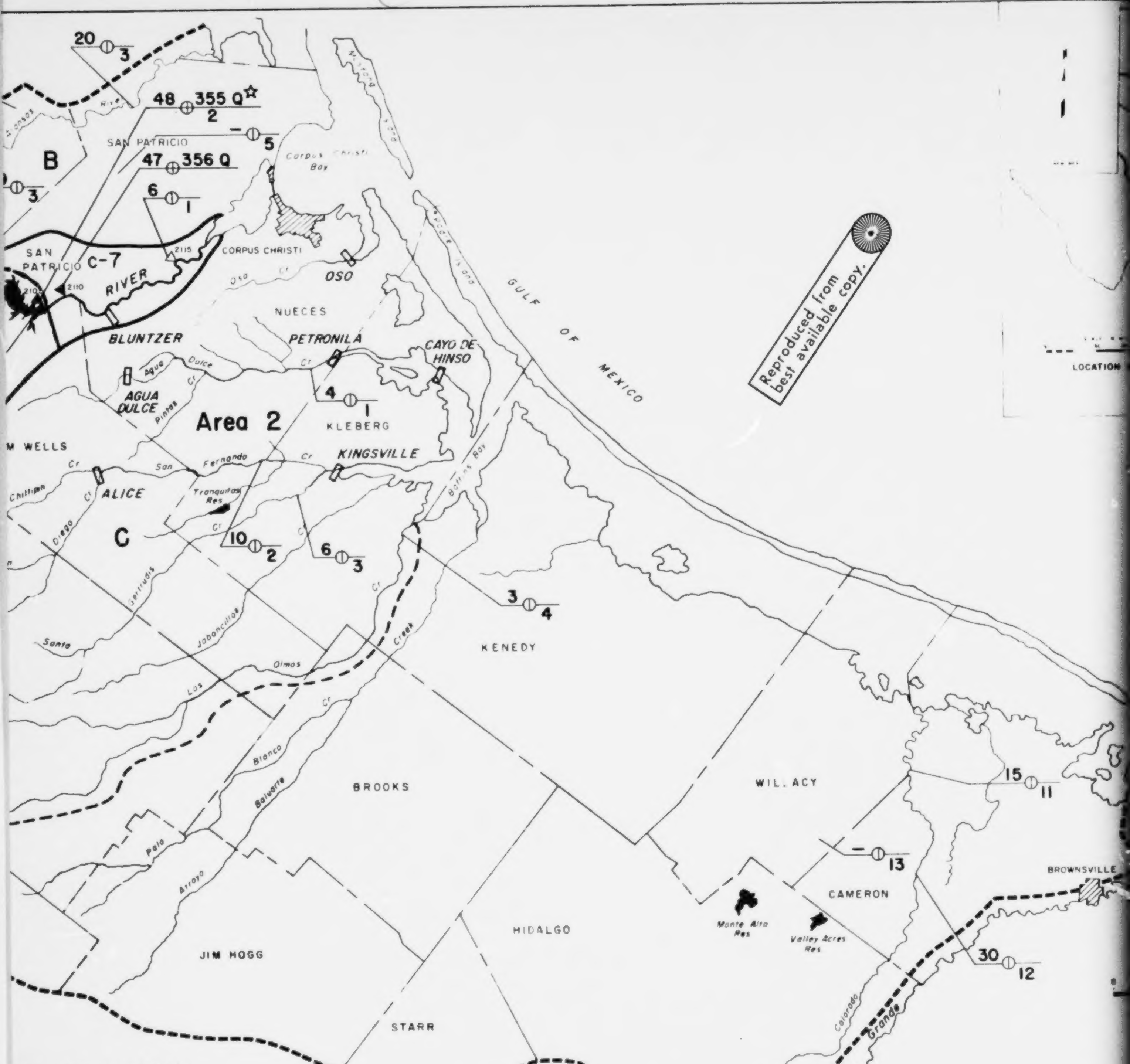

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3 4
Jaboncillos
Santa
KENEDY
Olmos
Los
Creek
Blanco
Baluarte
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Palo
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BROWNSVILLE
CAMERON
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Colorado
Arroyo
Grande
Rio
LOCATION

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DUCATION & WELFARE
HEALTH SERVICE
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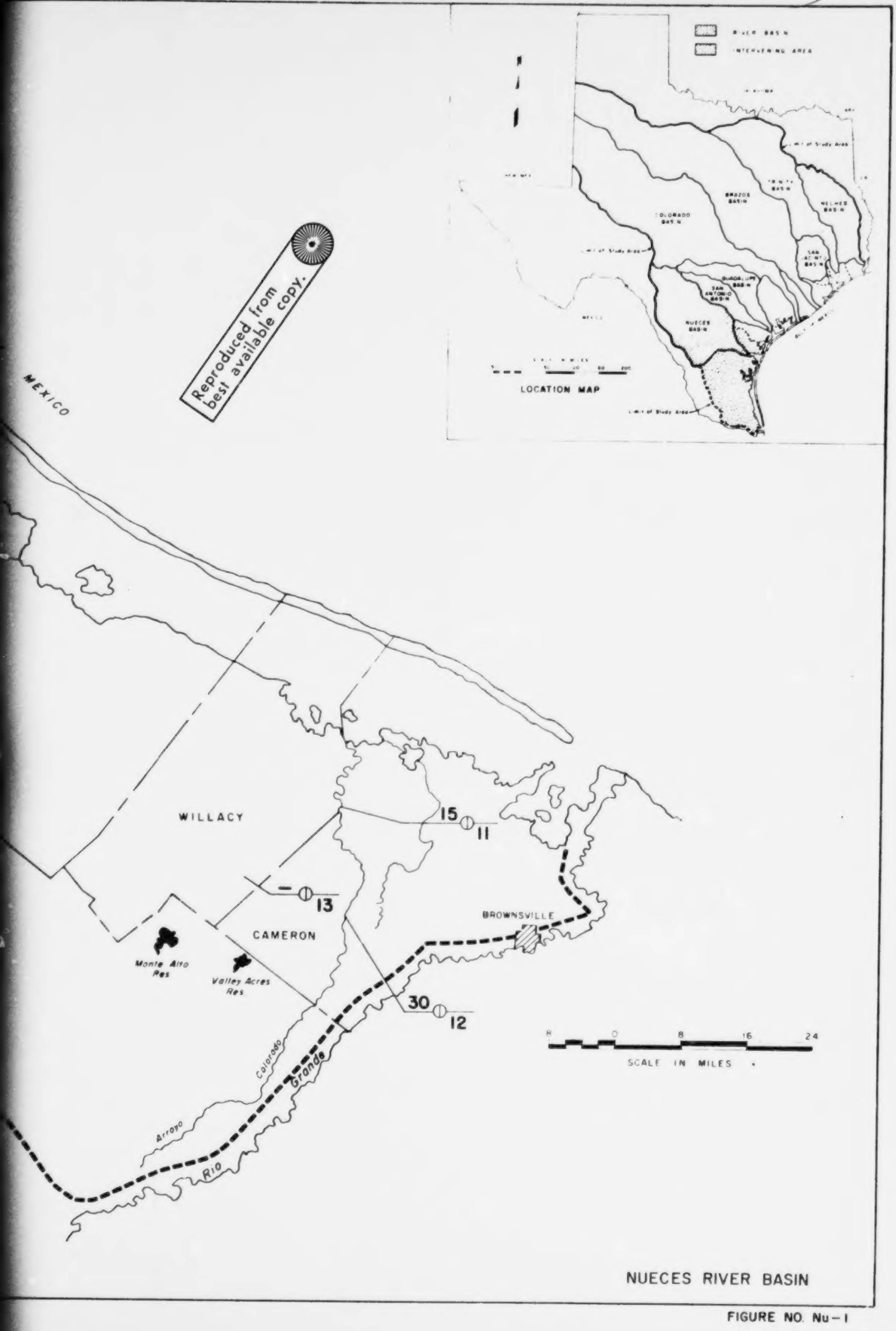
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NEW MEX
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BRAZOS BASIN
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GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
MEXICO
GULF OF MEXICO
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Arroyo Colorado
Rio Grande
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SCALE IN MILES

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NUECES RIVER BASIN

FIGURE NO. Nu-1

SAN ANTONIO RIVER BASIN

Present Quality of Water Resources in the San Antonio River Basin

Section, or Subarea	Page
Physical Description	219
1	220
2	221
3	223
4	223
Statement of Texas Department of Health	225

Physical Description

Geography

The San Antonio River flows about 237 miles in a southeasterly direction before it discharges to the Guadalupe River, about 11 miles from the Gulf of Mexico. The basin covers about 4,217 square miles and is bounded on the north and east by the Guadalupe River Basin and on the west by the Nueces River Basin.

Topography

As in the case of the Guadalupe Basin, the San Antonio River Basin is also divided into two physiographic regions. The Balcones Escarpment divides the headwaters into an upper portion, which is the Edwards Plateau region, and the lower portion, which is the Gulf Coastal Plains region.

Rainfall-Runoff

Average annual rainfall varies from about 25 inches in the headwaters to about 40 inches near the coast. The average annual runoff in acre-feet for the period of record 1940-56 was 400,545.

Impoundments

The two major impoundments are Lake Medina and the Medina Diversion Reservoir.

TABLE SA-1

SAN ANTONIO RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure SA-1)

2. San Antonio River from mile 237 to 144.
   Includes 74 miles of the Medina River.
   1. Medina River joins San Antonio River at mile 210.5.

4. San Antonio River from mile 144 to Guadalupe River (mile 11).
   3. Cibolo Creek joins San Antonio River at mile 131.

Present Quality of Surface and Ground Waters In Subareas of the San Antonio River Basin

Subarea 1

The farthest upstream discharge gage in the Basin is located at mile 90 on the Medina River. Average discharge during water year 1957-58 was 374 cfs. The average discharge for the preceding 16 year period of record was 107 cfs.

At mile 88, the Red Bluff Creek discharged about 26 cfs.

Medina Lake is formed by a dam at mile 76. This dam has been in operation since 1913. It has a total capacity at the spillway crest of 254,000 acre-feet and is used for irrigation of lands in the Bexar, Medina, Atascosa Counties Water Control and Improvement District No. 1.

The Medina Diversion Dam is located about four miles below the Medina Dam and has a total capacity of about 5,750 acre-feet. A discharge gage about .8 mile below the diversion dam showed an average discharge of 64.1 cfs during 1957-58. The average discharge for the preceding seventeen years was 22.5 cfs. All flow at this point is seepage from under and around the diversion dam except for occasional flow over the spillway of the dam.

Discharge at mile 5.2 of the Medina River averaged 203 cfs during 1957-58. Average discharge for the preceding eighteen years was 90.3 cfs. The city of San Antonio discharged approximately 14,060 acre-feet of sewage effluent from Mitchell Lake into the river above the gage during periods of high water. A considerable part of the low flow is waste water from Kelly Air Force Base, which enters by way of Leon Creek.

Ground waters in Subarea 1 are available in the Hensel sand of Travis Peak, Hosston formation, and some Edwards (fault zone) in eastern Medina County. Larger yields are in the northern part of the area. Edwards limestone is in the southeast corner only. A well in the city of Bandera yields over 350 gpm, probably from Hosston. Water collected from four wells of Bandera from 1945 to 1953 showed the following quality (known depths of wells Nos. 1 and 2 are 467 and 435 feet respectively):

Analysis	Concentration (ppm)
Total Solids	468-685
pH	7.5-8.0
Total Alkalinity	195-300
Silica	12- 16
Total Hardness	195-477
Calcium	40- 89
Magnesium	23- 62
Sodium	6-117
Iron	0.13-1.2
Manganese	0.5-0.5
Sulfate	48-218
Chloride	39- 67
Fluoride	1.5-2.1
Nitrate	0.4-0.9

The above analysis shows this water to be very hard, with a slight excess of fluoride.

Subarea 2

This subarea includes the San Antonio River from its origin at about mile 237 to mile 144. It also includes about 74 miles of the Medina River and all of Olmos Creek. At mile 232, the average discharge during water year 1957-58 was 28.2 cfs. Average discharge for the preceding 32 years was 57.1 cfs. A flood control reservoir with 15,500 acre-feet capacity is located about 8 miles upstream. The dam was completed in 1926. Normal flow of the river formerly came from springs located about eight miles upstream but now comes largely from artesian wells. Springs emerged from the Edwards limestone in the Balcones Fault Zone. Diurnal fluctuation is caused by industrial pumping from the wells above this station.

The Medina River discharged about 203 cfs to the San Antonio River during 1957-58. Quality of this water as recorded for the State Quality Monitoring Station No. 14 at mile 8 on the Medina River was as follows: dissolved solids ranged from 321 to 690 ppm (median 550); chlorides from 36 to 104 ppm (median about 70); sulfates from 86 to 195 ppm (median about 130); BOD ranged from 0.5 to 10.2, with 3 of 22 samples 7 ppm or greater.

Quality at mile 181 according to the records for the State Quality Monitoring Station No. 12 is as follows: total solids from 99 to 780 ppm, median 580; chlorides from 6 to 110 ppm, median about 100; sulfates from 14 to 129 ppm, median about 115; all BOD analyses less than 4 ppm with a range from 0.5 to 3.6 ppm.

At mile 151 the average discharge during 1957-58 was 525 cfs. The preceding 32 year period of record showed an average discharge of 293 cfs. The city of San Antonio discharged an average of 77 cfs of sewage effluent into the San Antonio River at San Antonio. State Quality Monitoring Station No. 11 is located at mile 151. Total solids ranged from 186 to 810 ppm (median 579); chlorides from 28 to 128 ppm; and sulfates from 42 to 142 ppm. BOD ranged from 0.5 to 3.3 ppm.

Ground waters in Subarea 2 are available from Edwards limestone and Carrizo-Wilcox formation.

The city of San Antonio used 85,612 acre-feet of ground water from Edwards limestone during 1958. San Antonio has 62 active wells, with depths ranging from 356 to 1,800 feet. The quality of water obtained from these wells, as sampled in the distribution system in July, 1953, is shown in the following analysis:

Analysis	Concentration (ppm)
Total Solids	280
pH	7.9
Total Alkalinity	240
Silica	7
Hardness (after treatment)	159
Hardness (raw well water)	209-266
Calcium (after treatment)	37
Calcium (raw well water)	54-80
Magnesium	16
Sodium	59
Iron	0.09
Sulfate	20
Chloride	18
Fluoride	0.2
Nitrate	2

Except for hardness, which is reduced by treatment, the water is of good quality.

Subarea 3

This is the watershed of Cibolo Creek which discharges to the San Antonio River at mile 131.

At mile 129 on Cibolo Creek, the average discharge during water year 1957-58 was 46.0 cfs. The preceding 12 year period of record showed an average of 9.79 cfs. Much of the flow enters sink holes and caverns in the Glen Rose limestone above this station.

At mile 75 the average flow for 1957-58 was 42 cfs with the preceding 12 year average of 11.3 cfs. Much of the flow enters the Edwards limestone in the Balcones Fault Zone which crosses the Basin between this station and the station near Bulverde (at mile 85).

State Quality Monitoring Station No. 16 is located at mile 60. Total solids ranged from 132 to 459 ppm (median 407); chlorides from 4 to 56 ppm; sulfates from 18 to 52 ppm; BOD from 0.5 to 11.2 ppm, with 3 values of 5.0 or greater.

At mile 9 the average flow for water year 1957-58 was 193 cfs. Average discharge for the preceding 27 year period of record was 115 cfs. Extreme fluctuations in discharge from 0 to 33,600 cfs are partly the result of the fact that much of the flow of the creek enters sink holes and caverns in the Glen Rose limestone and in the Edwards limestone in the Balcones Fault Zone.

Ground waters in Subarea 3 are available in the Edwards limestone reservoir and also in the Carrizo-Wilcox sands.

The city of Schertz used 330 acre-feet of water from the Edwards limestone reservoir during 1958. The quality of the water is similar to the analysis shown for San Antonio in Subarea 2.

Subarea 4

The San Antonio River flows from mile 144 to its mouth at mile 11 on the Guadalupe River. Escondido Creek discharges about 19.4 cfs to the San Antonio River at mile 113.

At mile 67 the 1957-58 discharge was 974 cfs. For the preceding 23 year period of record it was 523 cfs. Quality at mile 67 as recorded in Water Supply Paper 1050 (October, 1945-September, 1946) is as follows: dissolved solids, 261 to 1,040 ppm; total hardness, 146 to 428 ppm. Quality at this station (TDH No. 10) for the year 1957-58 is: total solids 233 to 900 ppm; chlorides 40 to 160 ppm; sulfates 26 to 153 ppm; BOD 0.5 to 6.4 ppm.

At mile 15 TDH Quality Monitoring Station No. 9 showed: total solids from 339 to 900 ppm, median 660; chlorides 24 to 152 ppm, median 120; sulfates 28 to 160 ppm, median 106; BOD from 0.5 to 3.7 ppm.

This represents the quality of the 974 cfs discharged to the Guadalupe from the San Antonio River Basin.

Ground waters in Subarea 4 are available in the Catahoula-Oakville-Lagarto formation, the Carrizo-Wilcox formation, Lagarto or Goliad, Goliad-Willis-Lissie, and a small area of Beaumont. Cities using these waters include Kenedy, Karnes City, and Goliad.

The city of Kenedy used about 470 acre-feet of water from the Catahoula-Oakville-Lagarto formation during 1958. Samples collected in 1945, 1948, and 1949 from six wells varying in depth from 399 feet to 747 feet had the following quality:

Analysis	Concentration (ppm)
Total Solids	1,328-2,100
pH	7.4-8.5
Total Alkalinity	330-370
Silica	56- 91
Total Hardness	160-442
Calcium	56-149
Magnesium	5- 17
Sodium	393-684
Iron	0.12-0.90
Sulfate	100-218
Chloride	412-738
Fluoride	0.5-2.8
Nitrate	4.0-7.0

The above analyses show this water to be unsatisfactory from the standpoint of total solids, total hardness, sodium, chloride, and occasionally iron and fluoride.

The city of Karnes City used 190 acre-feet of water from the Catahoula formation during 1958. This water is a soft bicarbonate water with a high sodium ratio. (III-2)

The city of Goliad used about 290 acre-feet of water from Lagarto or Goliad formations during 1958. Samples collected from the distribution system in 1948, which represent a composite of waters from three wells with depths of 185 feet, 515 feet, and 557 feet had the following quality:

Analysis	Concentration (ppm)
Total Solids	646
pH	7.4
Total Alkalinity	295
Silica	44
Total Hardness	326
Calcium	91
Magnesium	24
Sodium	103
Iron	0.2
Sulfate	43
Chloride	149
Fluoride	0.5
Nitrate	2.0

This water may be classified as very hard, but otherwise satisfactory.

STATEMENT OF TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE SAN ANTONIO RIVER BASIN*

Total Number of Sample Stations = 8
Total Number of Samples Taken = 412
Average Samples/Station = 52

Total Samples "Good" ----------------------------	346 for 84%
Total Samples "Poor" Organically and Chemically --	0
Total Samples "Poor" Organically Only ------------	66 for 16%
Total Samples "Poor" Chemically Only -------------	0

Remarks: The sampling of the San Antonio River Basin indicates results well within the Survey limits generally, with 62% of the total "Poor Organically" samples being from the station at the bridge on the county road between Southton and Buena Vista on the San Antonio River. None of the samples exceeded the chemical limits.

*Presented to the U. S. Study Commission - Texas, June 6, 1960.

TABLE SA-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE SAN ANTONIO RIVER BASIN

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2	San Antonio River	232	42*	310	1915-29 1939-	---	---	---
	San Pedro Creek	SP2.5 SA231	2.64**	311	1916-29	---	---	---
	San Antonio River	220	---	---	---	---	13	1957-60
1	Medina River	Me90 SA210	457	312	1922-34 1952-	---	---	---
	Red Bluff Creek	RB1.9 Me88	55.3	313	1956-	---	---	---
	Medina River Medina Lake	Me76	609	314	1913-	---	---	---
	Medina Canal		---	---	1922-34 1957-	---	---	---
2	Medina River	Me70	623	315	1922-34 1953-	---	---	---
	Medina River	Me45	---	---	---	---	15	1957-60

*Most of flow from artesian wells; drainage area of stream not applicable.
**Normal flow of creek comes from San Pedro Springs; drainage area not applicable.

Table SA-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2	Medina River	Me8	---	---	---	---	14	1957-60
	Medina River	Me3	1,225	316	1929-30 1939-	---	---	---
	Calaveras Creek	C5 SA192	77.2	317	1954-	---	---	---
	San Antonio River	191	1,786	318	1918-25	---	---	---
	San Antonio River	181	---	---	---	---	12	1957-60
	San Antonio River	151	2,071	319	1925-	---	11	1957-60
3	Cibolo Creek	Ci129 SA131	198	320	1946-	---	---	---
	Cibolo Creek	Ci85	251	321	1946-51	---	---	---
	Cibolo Creek	Ci75	280	322	1946-	---	---	---
	Cibolo Creek	Ci60	---	---	---	---	16	1957-60
	Cibolo Creek	Ci36	665	323	1924-29	---	---	---
	Cibolo Creek	Ci11	831	324	1930-	---	---	---
	Fork of Panther Cr. (of Escondido Cr.)	Es13 SA113	3.29	325	1954-	---	---	---

Table SA-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3	Escondido Creek	Es9	82.2	326	1954-	---	---	---
	Dry Escondido Creek	DE4 Es2	9.43	327	1954-	---	---	---
	San Antonio River	67	3,918	328	1924-29 1939-	1942-46	10	1957-60
	San Antonio River	15	---	---	---	---	9	1957-60

TABLE SA-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE SAN ANTONIO RIVER BASIN

Gua-9	Victoria County	Bridge, San Antonio River, U.S.Hwy.77 at McFadden
Gua-10	Goliad County	Bridge, San Antonio River, U.S. Hwy.77-A at Goliad (No. 29)
Gua-11	Karnes County	Bridge, San Antonio River, F.M. 791 SW Falls City (No. 22)
Gua-12	Wilson County	Bridge, San Antonio River, State Hwy. 97 at Floresville
Gua-13	Bexar County	Bridge, San Antonio River, County Road between Southton and Buena Vista S San Antonio
Gua-14	Bexar County	Bridge, Medina River, U.S. Hwy. 281 S San Antonio (No. 19)
Gua-15	Medina County	Bridge, Medina River, U.S. Hwy. 90 at Castroville
Gua-16	Bexar County	Bridge, Cibolo Creek, U. S. Hwy. 90 SE Randolph Air Force Base

TABLE SA-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL
SAN ANTONIO RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 2									
Alamo Heights	---	10,000	6 Wells	4.20	3,500	Mitchell Lake	272	242	---
San Antonio	227-237	513,000	75 Wells	68.5	487,200	Mitchell Lake, Olmos Cr., Dry Cr. to San Antonio R., Leon Cr., Cibolo Cr., San Antonio R.	345	250	---
MEDINA RIVER	210								
Subarea 1									
Bandera	---	1,300	2 drilled Wells	0.10	---	Medina Ri.	685	468	---
Subarea 2									
Castroville	---	925	2 Wells	0.102	---	---	275	257	---
La Coste	---	500	2 Wells	0.120	---	---	---	---	---

TABLE SA-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
CALAVERAS CREEK	192								
Saspamco	---	300	1 Well	---	---	---	955	---	---
Floresville	---	2,100	2 Wells	0.50	1,949	Land Irr.	438	396	---
MARCELINA CREEK									
Poth	---	1,200	2 Wells	0.15	680	Marcelina Wash	570	560	---
Subarea 4									
Falls City	---	425	1 Well	0.040	---	---	3,360	3,023	---
CIBOLO CREEK	131								
Subarea 3									
Boerne	---	2,250	6 Wells	0.30	---	Lagoons	909	403	---
Schertz	---	1,700	2 Wells	0.45	---	---	310	290	---
SANTA CLARA CREEK									
Cibolo	---	300	1 Well	0.025	---	---	2,868	2,440	---
MARTINEZ CREEK									
Converse	---	550	3 Wells	0.080	---	---	365	---	---
Stockdale	---	1,150	2 Wells	0.30	400	Clifton Branch	650	450	---

TABLE SA-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Subarea 4									
Runge	---	1,100	2 Wells	0.10	800	Ojo de Aqua Creek	967	890	---
ESCONDIDO CREEK	113								
Karnes City	---	2,800	3 Wells	0.176	2,070	Lagoons & Dry Cr. to Escondido Cr.	2,610	1,250	---
Kenedy	---	4,500	4 Wells	0.382	3,600	Escondido Cr.	2,275	1,238	---
Goliad	---	1,800	2 Wells	0.29	1,584	San Antonio R.	776	562	---
Tivoli	---	400	2 Wells	0.04	---	---	1,300	1,261	---

TABLE SA-4

SALINE GROUND WATERS IN THE SAN ANTONIO RIVER BASIN

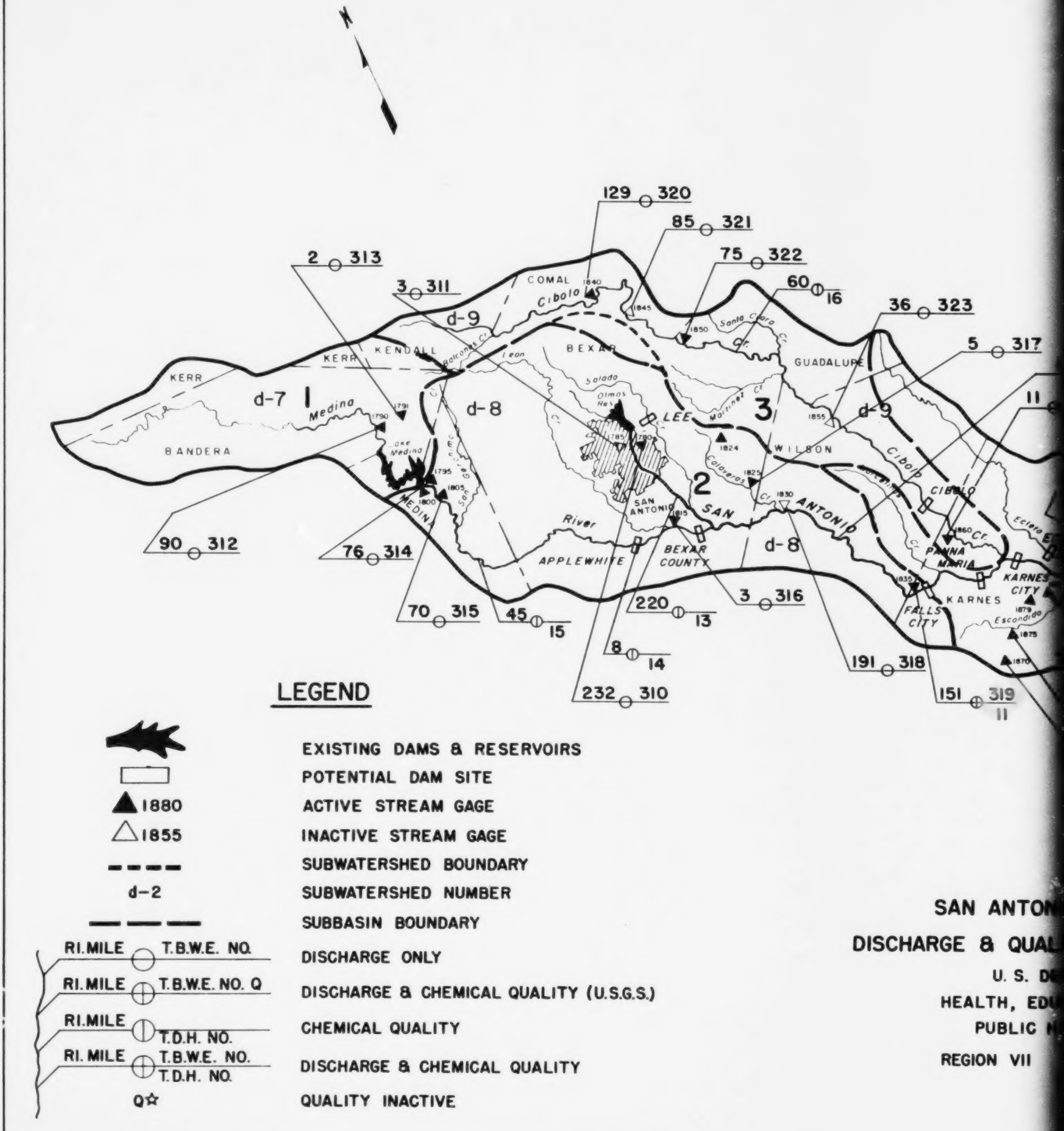
Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
2	K21	Bexar	1,610	21	2,380	Glen Rose Limestone	D, S	---	San Antonio
	K22	Bexar	1,380	17	2,370	Glen Rose Limestone	---	---	Medina River
	K49	Bexar	956	580	2,620	Trinity Group	---	---	Medina River
	K79	Bexar	2,040	1,040	4,690	Edwards Limestone	---	---	Cibolo Creek
	K80	Bexar	665	27	1,250	Edwards Limestone	N	---	San Antonio
	E37	Bexar	---	585	> 1,000	Carrizo Sand	P	---	San Antonio
3	K81	Guadalupe	1,200	1,000	>1,000	Edwards Limestone	P	---	Cibolo Creek
	E38	Wilson	604	180	1,130	Carrizo Sand	D	---	Cibolo Creek
	E69	Wilson	163	202	1,290	Claiborne Group	S	---	Cibolo Creek

*D, domestic; S, stock; P, public supply; N, none.

TABLE SA-4 (Continued)

Area	Well No.	County	SO_4 ppm	Clq ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
4	E49	Wilson	400	202	1,040	Queen City Sand	D, S	---	Cibolo Creek
	M12	Bee	81	428	1,120	Catahoula Sandstone	P	---	Mission River
	M13	Karnes	112	365	1,190	Catahoula Sandstone	P	79	San Antonio
	M14	Karnes	109	420	1,230	Catahoula Sandstone	P	92	San Antonio

A


N
KERR
KERR
KENDALL
COMAL
BEXAR
BANDERA
GUADALUPE
WILSON
KARNES
BEXAR COUNTY
d-7
1
d-8
d-9
3
d-9
2
d-8
Medina
Lake Medina
MEDINA
Cibolo
Balcones Cr.
Leon
Salado
Olmos Res.
LEE
Santa Clara Cr.
Martinez Cr.
Calaveras Cr.
Cibolo
CIBOLO
Cr.
Ecleto
SAN ANTONIO
River
APPLEWHITE
SAN ANTONIO
PANNA MARIA
KARNES CITY
FALLS CITY
Escondido
1790
1791
1795
1800
1805
1785
1780
1815
1824
1825
1830
1835
1840
1845
1850
1855
1860
1870
1875
1879
129 320
85 321
75 322
2 313
3 311
60 16
36 323
5 317
11
90 312
76 314
70 315
45 15
220 13
8 14
232 310
3 316
191 318
151 319 11
LEGEND
EXISTING DAMS & RESERVOIRS
POTENTIAL DAM SITE
1880 ACTIVE STREAM GAGE
1855 INACTIVE STREAM GAGE
SUBWATERSHED BOUNDARY
d-2 SUBWATERSHED NUMBER
SUBBASIN BOUNDARY
RI. MILE T.B.W.E. NO. DISCHARGE ONLY
RI. MILE T.B.W.E. NO. Q DISCHARGE & CHEMICAL QUALITY (U.S.G.S.)
RI. MILE T.D.H. NO. CHEMICAL QUALITY
RI. MILE T.B.W.E. NO. T.D.H. NO. DISCHARGE & CHEMICAL QUALITY
Q☆ QUALITY INACTIVE

SAN ANTON

DISCHARGE & QUAL

U. S. DE

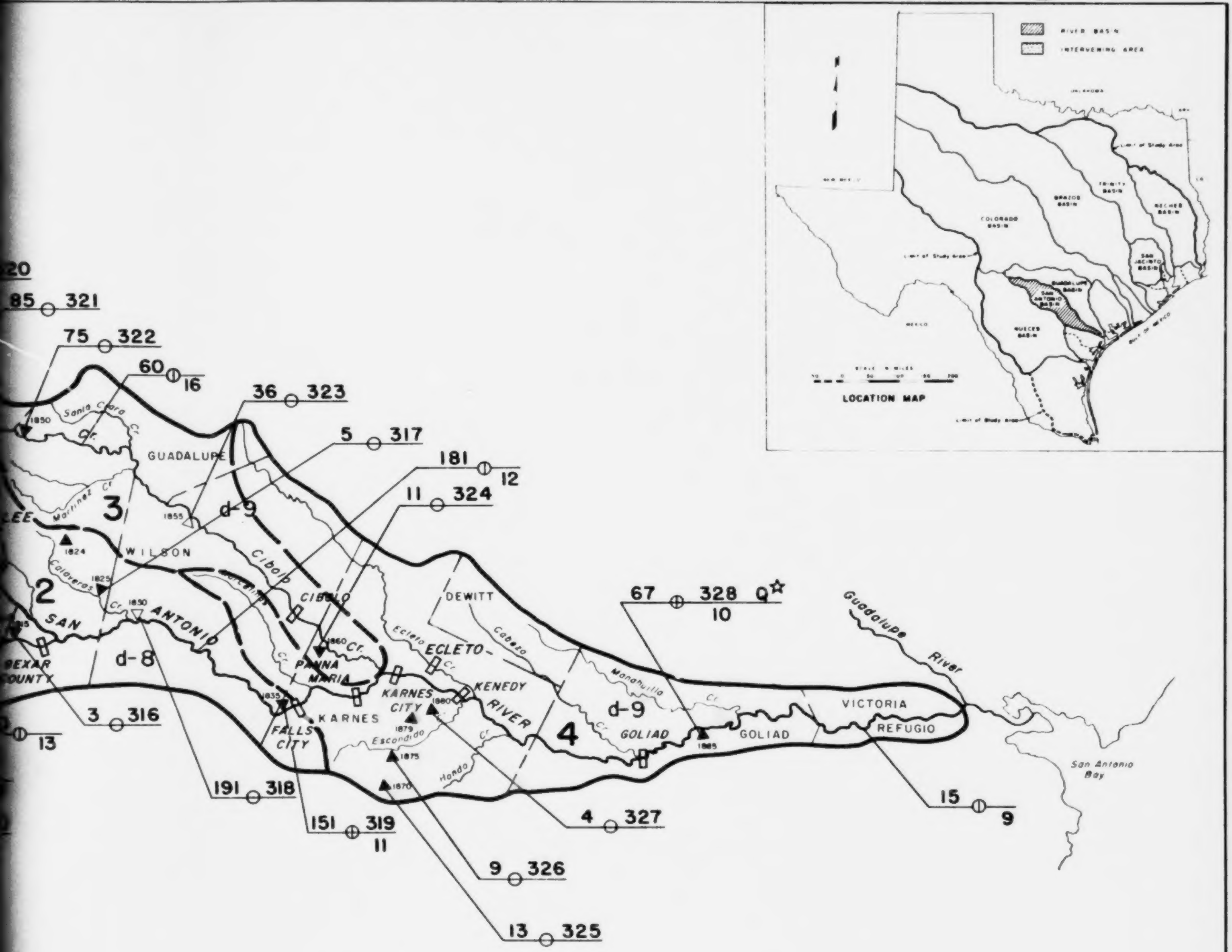
HEALTH, EDU

PUBLIC H

REGION VII

U.S. STUDY COMMISSION-TEXAS SA 35

234-A B



RIVER BASIN
INTERVENING AREA
COLORADO BASIN
BRAZOS BASIN
TRINITY BASIN
NECHES BASIN
SAN JACINTO BASIN
GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
MEXICO
NEW MEXICO
OKLAHOMA
Limit of Study Area
Gulf of Mexico
SCALE IN MILES
LOCATION MAP
20
85 321
75 322
60 16
36 323
5 317
181 12
11 324
67 328 10 Q
3 316
13
191 318
151 319 11
9 326
13 325
4 327
15 9
1850
1855
1824
1825
1830
1835
1860
1879
1880
1875
1870
1885
Santa Clara Cr.
Martinez Cr.
GUADALUPE
WILSON
Calaveras Cr.
SAN ANTONIO
BEXAR COUNTY
Cibolo
CIBOLO Cr.
PANNA MARIA
FALLS CITY
KARNES
KARNES CITY
Escondido
Hondo Cr.
Ecleto Cr.
ECLETO
KENEDY
RIVER
DEWITT
Cabeza
Manahuila Cr.
GOLIAD
VICTORIA
REFUGIO
Guadalupe River
San Antonio Bay
2
3
4
d-8
d-9
d-9
8 0 8 16 24
SCALE IN MILES

SAN ANTONIO RIVER BASIN

DISCHARGE & QUALITY SAMPLING STATIONS

U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

SAN ANTONIO RIVER BASIN

FIGURE NO. SA-1

SAN JACINTO RIVER

Present Quality of Water Resources in the San Jacinto River Basin

Section, or Subarea	Page
Physical Description	235
2	236
1	237
3-4	238
3	239
4	240
Statement of Texas Department of Health	241

Physical Description

Geography

The San Jacinto River has a total length of about 150 miles measured along its stream bed. It has an over-all air line length of 93 miles and a maximum air line width of 67 miles. It drains an area of approximately 550 square miles and is bounded by the Trinity River Basin on the east and north and by the Brazos River Basin on the west.

Topography

The northern 70 per cent of the basin is a gently rolling, sandy area occupied by pine and hardwood forests and slow draining soils. The remainder of the basin is flat and treeless and has heavy dark clay and sandy loam soils. Streams throughout the basin have gentle slopes and relatively small channel capacities.

Rainfall-Runoff

Average annual rainfall increases from about 43 inches at the northern end of the basin to about 50 inches at Galveston Bay. Runoff varies greatly, as indicated by stream gaging records for the station near Huffman. Average runoff for the period of record 1936-53 was 1,418,000 acre-feet per year.

TABLE SJ-1

SAN JACINTO RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure SJ-1)

1. East Fork San Jacinto River Basin.

2. West Fork San Jacinto River Basin.

3-4. San Jacinto River from mile 28 to mouth (Trinity Bay). (Boundary of Subareas 3 and 4).
   3. Area west of San Jacinto River.
   4. Area east of San Jacinto River.

Present Quality of Surface and Ground Waters In Subareas of San Jacinto River

Subarea 2

Subarea 2 includes about 94 miles of the West Fork of the San Jacinto River and drains about 1,856 square miles. The farthest upstream quality records are at mile 79. Discharge for the year 1957-58 averaged 685 cfs. Average discharge for the preceding 22 year period of record was 530 cfs. State Quality Monitoring Station No. 5 is also located at mile 79. Total solids ranged from 44 to 555 ppm, median 100; chlorides from 8 to 108 ppm; sulfates from 1 to 22 ppm; BOD from 0.5 to 3.5 ppm.

Spring Creek joins the West Fork San Jacinto at mile 50. Average discharge at mile 17 on Spring Creek was 229 cfs for water year 1957-58. The preceding 19 year period of record showed 218 cfs. There is no quality data for this station. Cypress Creek joins Spring Creek at about mile 4 and discharges about 162 cfs to Spring Creek.

Average discharge at mile 50 on the West Fork San Jacinto for the period of record 1928-54 was 1,097 cfs. The latest quality data for this station is recorded in Water Supply Paper 1050 for water year 1945-46. Dissolved solids ranged from 110 to 347 ppm; total hardness from 26 to 120 ppm.

Ground waters in Subarea 2 are available in Oakville sandstone, Catahoula, and sands of the Lagarto clay. The city of Conroe used 1,090 acre-feet of this water in 1958. Samples collected from the distribution system of Conroe, which represent a composite of water from three wells having depths of 205, 1,221, and 221 feet, as of May, 1953, had the following quality.

Analysis	Concentration (ppm)
Total Solids	352
pH	8.3
Total Alkalinity	185
Silica	22
Total Hardness	132
Calcium	41.0
Magnesium	7.0
Sodium	70.0
Iron	0.58
Sulfate	26
Chloride	59
Fluoride	0.1

The above analysis represents a very satisfactory water supply.

Subarea 1

Subarea 1 is the watershed of the East Fork San Jacinto River. The East Fork is about 72 miles long and drains an area of about 931 square miles.

The farthest upstream station having quality and discharge data is at mile 71. Average discharge for the water year 1957-58 was 50.3 cfs. The average discharge for the preceding 15 years was 259 cfs. State Quality Monitoring Station No. 1 indicates the following quality: total solids from 150 to 1,200 ppm, median 362; chlorides 40 to 580 ppm, median 150; sulfates 1 to 19 ppm, median 10; BOD 0.5 to 2.7 ppm.

Peach Creek joins the East Fork at mile 46. At about mile 10 on Peach Creek the average discharge for water year 1957-58 was 84.1 cfs. The average discharge for the preceding 14 years of record was 73.9 cfs. State Quality Monitoring Station No. 3 showed the following quality: total solids from 25 to 720 ppm, median 70; chlorides from 4 to 290 ppm, median 24; sulfates from 1 to 46 ppm, median about 10; BOD from 0.5 to 4.8 ppm, with 3 values of 4 ppm or more.

Caney Creek discharges approximately 82 cfs to Peach Creek at about mile 4. State Quality Monitoring Station No. 4 indicates the following quality in the Caney Creek discharge: total solids from 24 to 318 ppm, median 91; chlorides from 4 to 138 ppm; sulfates from 1 to 43 ppm; BOD from 0.5 to 3.4 ppm.

Ground waters in Subarea 1 are available in the sands of the Catahoula-Oakville-Lagarto clay.

The city of Cleveland used 620 acre-feet of this water during 1958. Samples of water collected from the distribution system of Cleveland which represent a composite of three wells (known depths of two of them, 845 and 929 feet) had the following quality as of May, 1952.

Analysis	Concentration (ppm)
Total Solids	378
pH	8.2
Total Alkalinity	265
Silica	17
Total Hardness	126
Calcium	37
Magnesium	8
Sodium	93
Iron	0.22
Sulfate	23
Chloride	28
Fluoride	0.1

The above analysis indicates a satisfactory water quality.

Subarea 3-4

The San Jacinto River forms the boundary of these two subareas at mile 38 just below the junction of West and East Forks of the San Jacinto River. The average discharge for the period of record 1936 to 1953 (at which time the station was discontinued) was 1,958 cfs. Chemical quality at this station was recorded in Water Supply Paper 1292 for water year 1952-53. In a weighted average flow of 1,372 cfs, there were 30 ppm chlorides, 5.2 ppm sulfates, 41 ppm hardness, and 102 ppm dissolved solids (378 tons per day).

Lake Houston is formed by a dam located at approximately mile 35. Total capacity of this impoundment is 158,200 acre-feet. It was completed and storage began April 9, 1954. Water from this impoundment is used for municipal supply for the city of Houston, for industries in the ship channel area, and for irrigation.

Subarea 3

This subarea covers 1,487 square miles. It includes the Houston municipal and industrial complex which has seventeen separate sewage and waste outfalls listed in the 1957 Inventory of Municipal and Industrial Waste Facilities.

At mile 51 on Buffalo Bayou the average discharge during period of record 1945-47 was 155 cfs.

Barker and Addicks Reservoirs are operated for flood protection of the city of Houston. The average discharge for 1957-58 was 220 cfs 3.2 miles downstream from the outlet works of the Barker Reservoir and 3 miles downstream from the outlet works of Addicks Reservoir. Average discharge for the preceding nine years was 183 cfs.

Buffalo Bayou at Houston, Texas, (mile 30) had an average discharge of 162 cfs during 1957-58. The average discharge for the preceding eighteen years was somewhat greater, 268 cfs. Flood flows at this station are regulated by Barker and Addicks Reservoirs. Extremely low flows are sustained by the drainage from irrigated lands and by industrial waste water.

White Oak Bayou discharges approximately 69.5 cfs to the Buffalo Bayou at mile 27. Low flows are partly sustained by industrial wastes.

Brays Bayou discharged an average 81.1 cfs during water year 1957-58 to Buffalo Bayou at about mile 17. Low flow in Brays Bayou is partly maintained by sewage effluent from Houston suburbs and was partially regulated for most of the year by construction dams upstream from the gage. Sims Bayou discharged an average 72.6 cfs during water year 1957-58 at mile 15 on Buffalo Bayou. Low flows in Sims Bayou are also largely sewage effluents from Houston suburbs and drainage from lands irrigated with ground water. Diversions above station for irrigation.

Greens Bayou enters the Buffalo Bayou at mile 8. At mile 23 on Greens Bayou the average discharge during water year 1957-58 was 42.4 cfs. An additional 19.2 cfs were added by Halls Bayou which enters Greens Bayou at mile 10. Halls Bayou has its low flows partly sustained by sewage effluent from Houston suburbs. There are no quality monitoring stations in Subarea 3 or 4.

Ground waters in Subarea 3 are from Goliad-Willis-Lissie sands that vary from 400 to 2,800 feet deep. Major cities using water from this source are Houston and Pasadena.

The city of Houston used 112,450 acre-feet of ground water as well as 77,000 acre-feet of surface water during 1958.

Houston has 106 wells located at six well fields. The wells vary in depth from 777 feet to 2,063 feet. Considering the distribution system to represent a composite of all these wells the following quality is indicated from a sample collected in June, 1953:

Analysis	Concentration (ppm)
Total Solids	380
pH	7.8
Total Alkalinity	235
Silica	26
Total Hardness	76
Calcium	22
Magnesium	5
Sodium	125
Iron	0.07
Sulfate	17
Chloride	67
Fluoride	0.6

The above analysis shows this to be water of good quality.

Subarea 4

Ground waters in Subarea 4 are from undistinguishable formations in sands that extend from 600 to 1,000 feet. Salt water occurs from 1,600 to 2,800 feet.

The city of Baytown used 2,950 acre-feet of this water during 1958. Baytown has eight wells that are between 500 and 600 feet deep. A sample of this water collected in January, 1960 showed the following quality:

Analysis	Concentration (ppm)
Total Dissolved Solids	865
Total Hardness	47
Sulfate	41
Chloride	123

This water appears to be of good quality.

A report entitled Study of Chemical Quality of Water from Trinity and San Jacinto Rivers was prepared for the San Jacinto River Authority by W. F. White and S. W. Freese in 1959. The following are excerpts from that report.

Page 1, paragraph 1 -- General Statement

> "The purpose of this study is to determine the probable future chemical quality of water from the proposed Livingston Reservoir on the Trinity River and from Lake Houston on the San Jacinto River, with respect to chlorides, total dissolved solids, and hardness, also to determine the costs of treating the two waters for cooling purposes."

The study is based on data covering a period of thirteen years 1946-58. White and Freese conclude that the following quality may be expected in the San Jacinto River waters at Lake Houston: chlorides, 42 ppm; dissolved solids, 165 ppm; total hardness, 56 ppm; noncarbonate hardness, 17 ppm. (III-3)

Unless kept under close control, oil field brines may be a source of quality degradation. Evaporation from Lake Houston has already been reported to have increased salt concentration during periods of low runoff.

STATEMENT OF THE TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE SAN JACINTO RIVER BASIN*

Total Number of Sample Stations = 5
Total Number of Samples Taken = 229
Average Samples/Station = 46

Total Samples "Good" ----------------------------	169 for 74%
Total Samples "Poor" Organically and Chemically ---	3 for 1%
Total Samples "Poor" Organically Only ------------	37 for 16%
Total Samples "Poor" Chemically Only -------------	20 for 9%

Remarks: The results of the sampling of the San Jacinto Basin disclose generally satisfactory conditions with occasional samples indicating slight excesses in chlorides and chlorine demand.

*Presented to the U. S. Study Commission - Texas, June 6, 1960.

TABLE SJ-2

LOCATION OF QUALITY AND DISCHARGE STATIONS WITH PERIOD OF RECORDS IN THE SAN JACINTO RIVER BASIN

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2	West Fork San Jacinto River	79	832	132	1924-27 1939-	---	5	1957-60
	Spring Creek	17 SJ-54	400	133	1939-	---	--	---
	Cypress Creek	CY-11 SP-4	262	134	1944-	---	--	---
	West Fork	50	---	135	1928-54	1941-46	--	---
	East Fork	71 SJ-39	330	136	1939-	---	1	1957-60
	Peach Creek	10 EFSJ-46	120	137	1943-	---	--	---
	Peach Creek	7	---	---	---	---	3	1957-60
	Caney Creek	C-9	104	138	1943-	---	4	1957-60
3,4	San Jacinto River	38	---	139	1936-53	1945-54	--	---
	San Jacinto River (Lake Houston)	29	2,811	140	1954-	---	--	---

TABLE SJ-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
3	Buffalo Bayou	51	310	141	1945-	---	--	---
	Buffalo Bayou	30	362	142	1936-57	---	--	---
	Whiteoak Bayou	W-4.1 BB-27	92.0	143	1936-	---	--	---
	Brays Bayou	Br-10.8 BB-17	10	144	1936-	---	--	---
	Sims Bayou	Si-5.6 BB-15	64.0	145	1952-	---	--	---
	Greens Bayou	23 BB-8	67.5	146	1952-	---	--	---
	Halls Bayou	H-11 G-11	26.2	147	1952-	- ---	--	---

TABLE SJ-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE SAN JACINTO RIVER BASIN

SJa-1	Liberty County	Bridge, East Fork San Jacinto, State Hwy. 105 at Cleveland (No. 5)
SJa-2	Liberty County	Bridge, Cedar Bayou, U. S. Hwy. 90 SW Dayton
SJa-3	Montgomery County	Bridge, Peach Creek, U. S. Hwy. 59 S Splendora (No. 6)
SJa-4	Montgomery County	Bridge, Caney Creek, County road between Conroe and Splendora near Ben Milam School (No. 7)
SJa-5	Montgomery County	Bridge, West Fork San Jacinto River, U. S. Hwy. 75 S Conroe (No. 1)

TABLE SJ-3*

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL
SAN JACINTO RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
SAN JACINTO RIVER									
EAST FORK	39								
TRIBUTARY									
NEBBLETS CREEK									
TRIBUTARY									
Cleveland		6,500	3 wells	0.38	6,000	E. San Jacinto River	378	348	---
PEACH CREEK									
Fostoria		1,200	2 wells	0.10	--	--	---	---	---
CANEY CREEK									
LUCE BAYOU									
TARKINGTON BAYOU									

*Mileages are measured by continuing up the West Fork from the confluence with the East Fork with mileages begun at the Gulf of Mexico

TABLE SJ-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
WEST FORK									
WEST SANDY CREEK									
MCDONALD CREEK									
EAST SANDY CREEK									
TRIBUTARY									
CANEY CREEK	101 *								
LITTLE LAKE CREEK	97 *								
TRIBUTARY									
Montgomery		350	2 wells	---	--	--	---	---	---
LAKE CREEK	83 *								
Shiro		200	1 well	0.005	--	--	750	---	---

TABLE SJ-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge to	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
CEDAR CREEK									
MOUND CREEK									
TRIBUTARY									
Conroe		10,000	2 wells	0.943	5,000	Town Creek of San Jacinto R.	382	352	---
CRYSTAL CREEK									
PANTHER CREEK									
SPRING CREEK	51								
BRUSHY CREEK									
WALNUT CREEK									
MILL CREEK									
Hufsmith		150	1 well	--	--	--	---	---	---
WILLOW CREEK									

TABLE SJ-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Source	Use mgd	Waste Disposal Population Served 1957	Discharge to	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
Spring		500	1 well	0.02	--	--	---	---	---
LITTLE CYPRESS CREEK									
TRIBUTARY									
Wallor		800	1 well	0.047	--	--	401	---	---
Crosby		1,100	2 wells	0.14	--	--	---	---	---
Highlands		7,900	Wells	--	--	--	461	452	---
BUFFALO BAYOU									
Houston		960,000	106 wells, Lake Houston	96.0	--	17 outfalls, mostly Buffalo Bayou tidewater	611 (well)	147 (San Jacinto)	395

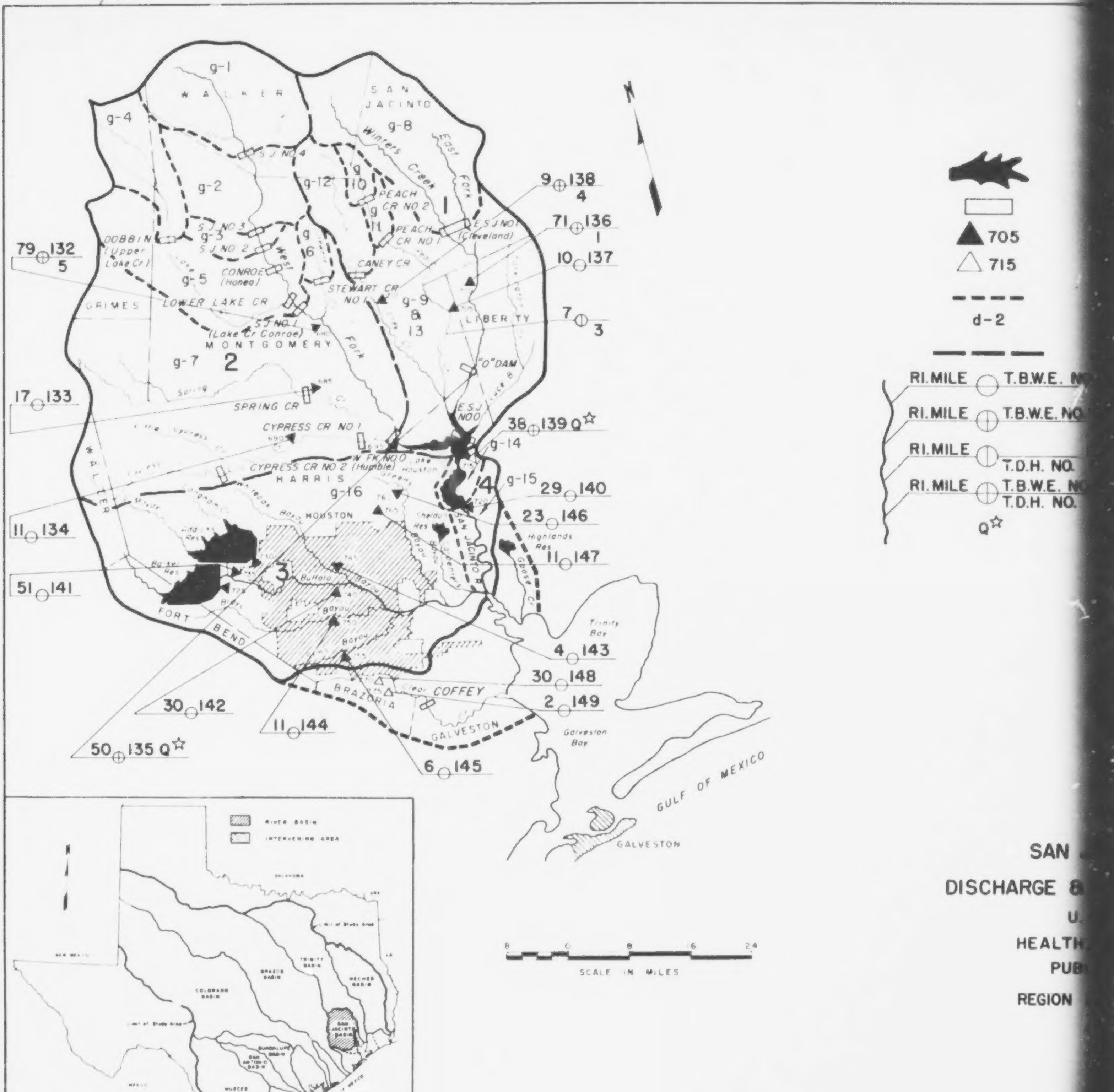
TABLE SJ-4

SALINE GROUND WATERS IN THE SAN JACINTO RIVER BASIN

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
3	0-58	Harris	0.7	305	1,100	Lissie Formation	N	--	San Jacinto
	0-59	Harris	0.8	1040	2,380	Lissie Formation	N	--	San Jacinto

*N, None.

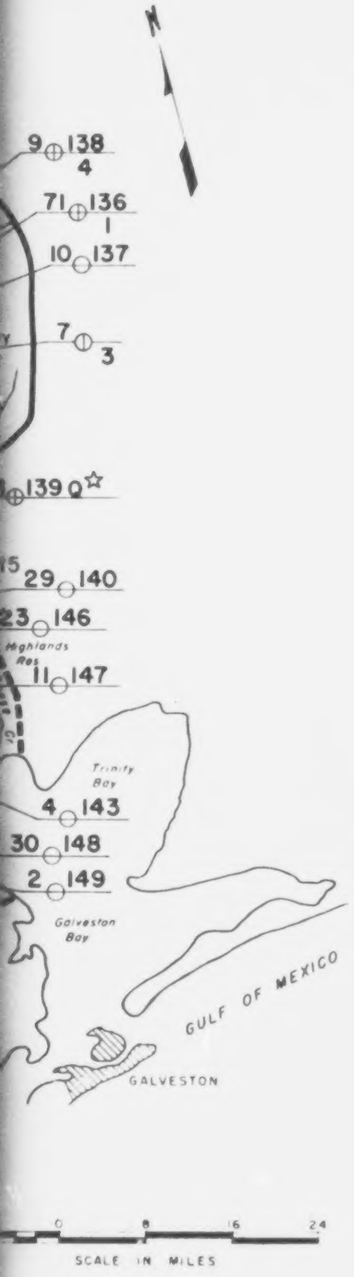
A



g-1
WALKER
SAN JACINTO
g-4
g-8
Winters Creek
East Fork
S J NO 4
g-2
g-12
g 10
PEACH CR NO 2
1
9 138 4
71 136 1
E S J NO 1 (Cleveland)
DOBBIN (Upper Lake Cr)
g-3
S J NO 3
S J NO 2
g 6
g 11
PEACH CR NO 1
79 132 5
West
CONROE (Honea)
CANEY CR
10 137
g-5
GRIMES
LOWER LAKE CR
STEWART CR NO 1
g-9 & 13
S J NO 1 (Lake Cr Conroe)
LIBERTY
7 3
MONTGOMERY
Fork
g-7
2
"O" DAM
17 133
Spring
SPRING CR
E S J NO 0
38 139 Q☆
CYPRESS CR NO 1
g-14
W FK NO 0
Lake Houston
CYPRESS CR NO 2 (Humble)
HARRIS
4
g-15
29 140
WALLER
g-16
HOUSTON
23 146
11 134
Addicks Res
Sheldon Res
SAN JACINTO R
Highlands Res
11 147
Barker Res
3
Buffalo Bayou
Goose Cr
51 141
FORT BEND
Trinity Bay
4 143
30 148
BRAZORIA
Clear
COFFEY
2 149
30 142
11 144
GALVESTON
Galveston Bay
50 135 Q☆
6 145
GULF OF MEXICO
GALVESTON
N
705
715
d-2
RI. MILE T.B.W.E. NO
RI. MILE T.B.W.E. NO
RI. MILE T.D.H. NO
RI. MILE T.B.W.E. NO T.D.H. NO
Q☆
SAN
DISCHARGE &
U.
HEALTH,
PUB
REGION
8 0 8 16 24
SCALE IN MILES
RIVER BASIN
INTERVENING AREA
NEW MEXICO
OKLAHOMA
COLORADO BASIN
BRAZOS BASIN
TRINITY BASIN
NECHES BASIN
SAN JACINTO BASIN
GUADALUPE BASIN
SAN ANTONIO BASIN
NUECES BASIN
MEXICO
LOCATION MAP

SAN JACINTO RIVER BASIN

250 B


N
9 138 4
71 136 1
10 137
7 3
139 Q☆
15 29 140
23 146
Highlands Res
11 147
Trinity Bay
4 143
30 148
2 149
Galveston Bay
GULF OF MEXICO
GALVESTON
0 8 16 24
SCALE IN MILES

LEGEND

■	EXISTING DAMS & RESERVOIRS
▭	POTENTIAL DAM SITE
▲ 705	ACTIVE STREAM GAGE
△ 715	INACTIVE STREAM GAGE
- - - -	SUBWATERSHED BOUNDARY
d-2	SUBWATERSHED NUMBER
— — —	SUBBASIN BOUNDARY
RI. MILE ○ T.B.W.E. NO.	DISCHARGE ONLY
RI. MILE ⊕ T.B.W.E. NO. Q	DISCHARGE & CHEMICAL QUALITY (U.S.G.S.)
RI. MILE ⦶ T.D.H. NO.	CHEMICAL QUALITY ONLY
RI. MILE ⊕ T.B.W.E. NO. T.D.H. NO.	DISCHARGE & CHEMICAL QUALITY
Q☆	QUALITY INACTIVE

SAN JACINTO RIVER BASIN
DISCHARGE & QUALITY SAMPLING STATIONS
U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

SAN JACINTO RIVER • BASIN

FIGURE NO SJ-1

TRINITY RIVER BASIN

Present Quality of Water Resources in the Trinity River Basin

Section, or Subarea	Page
Physical Description	251
1	253
4	255
2	256
3	258
5	260
6	261
7	263
8	264
9	267
10	268
Statement of Texas Department of Health	269

Physical Description

Geography

The Trinity River Basin lies in the eastern half of Texas and is an area about 70 miles wide extending from the northern part of Texas in a general southeasterly direction about 350 miles to Galveston Bay. The river measured along its stream bed has a total length of about 650 miles, draining an area of approximately 17,760 square miles. The Basin is situated entirely in the State of Texas and is bounded on the north by the watershed of the Red River, on the east by the watersheds of the Sabine and Neches Rivers, on the west by the watersheds of the Brazos and San Jacinto River Basins, and on the south by the Gulf of Mexico.

Topography

The headwater tributaries of the Trinity drain a fan-shaped, hilly area and converge to form the main stem near Dallas, where the general character of the terrain changes to gently sloping hills. The river rises at an elevation of about 1,250 feet, 700 miles from the mouth, then drops rapidly for 200 miles to about 400 feet at Dallas and discharges at sea level into Galveston Bay. In general, except for woodlands and forests interspersed with small, irregularly shaped cultivated fields, the southeastern two-thirds of the Basin is devoted to general farming. Land use in the northwestern part is predominantly grazing and ranching. The Basin generally presents an appearance of smooth plains with more or less distinct escarpments facing the northwest and increasing in predominance toward the headwaters, where the topography is somewhat rougher.

Rainfall-Runoff

The climate of the Trinity Basin is characterized by its diversity and sudden changes, varying from dry, subhumid in the upper portion to humid in the lower portion. The entire area is subject to extremely heavy rainstorms and occasional hurricanes in the Gulf area. The average temperatures in the upper portion of the Basin vary from 42°F in winter to 85°F in the summer. Average temperature in the lower portion varies from 54° in the winter to 83°F in the summer. Rainfall varies from 28 inches a year at the headwaters to 45 inches at the Gulf. The average growing season in the upper half is about 230 days and in the lower half, about 340 days. Runoff varies from year to year and also markedly from season to season. Periods of zero flow have been experienced at all the gaging stations on the tributaries of the Trinity River. The last statement does not apply to the gaging station at Grand Prairie on the West Fork; at this station upstream sewage effluents prevent the occurrence of zero flows. Average annual runoff for the entire Trinity River Basin, for the period 1940-56, was 5,808,817 acre-feet.

Impoundments

There are twenty-four major reservoirs (over 5,000 acre-feet capacity) in the Trinity River Basin, having a total capacity of 2,893,158 acre-feet. There are also more than 62,000 minor reservoirs, having a total capacity of more than 307,000 acre-feet. These minor reservoirs were constructed for various purposes, including municipal, industrial, irrigation, mining, power, flood control, and recreation.

Table T-1

TRINITY RIVER BASIN
SUBAREA LOCATIONS ON THE MAIN STEM
(As shown on Figure T-1)

5. Trinity River from origin (mile 506) to mile 385.
   Subarea 5 also includes:
      West Fork from mile T-519 to junction with Trinity (T-506).
      Elm Fork from mile 18 to junction with Trinity (T-506).
      Entire White Rock Basin to junction with Trinity (T-493).
   4. West Fork from mile 596 to mile 519.
      1. West Fork Headwaters to mile 596.
   2. Elm Fork Headwaters to mile 18.
   3. East Fork joins Trinity at mile 460.

7. Trinity River from mile 385 to mile 372.
   Includes Cedar Creek which joins Trinity at mile 385.5.
   6. Chambers Creek Watershed T-373 R-14 co.

8. Trinity River from mile 372 to mile 181.

9. Trinity River from mile 181 to mile 43.

10. Trinity River from mile 43 to mouth (Galveston Bay).

11. Adjoining area to Galveston Bay.

Present Quality of Surface and Ground Waters In Subareas of the Trinity River Basin

Subarea 1

Subarea 1 is the headwater portion of the West Fork of the Trinity. River miles for the West Fork are an extension of the Trinity river miles. The West Fork rises in Archer County, passes through Jack County receiving the run-off from North Creek and Crooked Creek, is impounded in Lake Bridgeport in Wise County, receives the run-off from Sandy Creek, and passes into Subarea 4 at mile 596.

The farthest upstream gaging station is located on North Creek, which registered an average flow of 6.8 cfs during water year 1957-58. There are no corresponding quality data for this station.

At mile 660, the average discharge for 1957-58 was 119 cfs. This represents the inflow to Lake Bridgeport. Quality at this point as recorded under State Quality Monitoring station No. 17 is: total dissolved solids from 67 to 483 ppm, median 303; chlorides 16 to 176 ppm, median 108; sulfates 9 to 61 ppm, median 18 ppm; BOD ranged from 0.5 to 6.6 with two values 4.0 or greater.

Bridgeport Reservoir is formed by a dam located at mile 626. The dam was completed December 15, 1931, and storage began April 1, 1932. The reservoir is used for flood control and municipal supply for the city of Fort Worth. The quality of the lake water as recorded by the city of Fort Worth for a sample collected in December, 1952, showed total solids of 220 ppm, hardness 131 ppm, chlorides 14 ppm, sulfates 26 ppm, and iron 1.3 ppm.

The quality of water in Bridgeport Reservoir may be assumed to be the quality of flow entering Subarea 4, which was 391 cfs during water year 1957-58.

Subarea 1 obtains small amounts of water from the Canyon group and Cisco group of Pennsylvanian age.

The city of Jacksboro contains a well field in the Canyon group. Analysis of a composit sample from eighteen wells in 1946 showed the following quality:

Analysis	Concentration (ppm)
Dissolved Solids	441
Total Hardness	84
Silica	12
Iron	1.0
Calcium	25
Magnesium	5.2
Sodium	136
Potassium	9.9
Bicarbonate	378
Sulfate	32
Chloride	32
Fluoride	0.8
Nitrate	2.0

This analysis shows the water to be of good quality.

The city of Bryson obtains its water supply from the Cisco group with eight wells varying in depth of 135 to 300 feet. The quality as shown in an analysis made in 1946 was as follows:

Analysis	Concentration (ppm)
Dissolved Solids	603-921
Total Hardness	38- 79
Silica	8- 11
Iron	.01-4.3
Calcium	10- 19
Magnesium	3.3-6.2
Sodium	193-325
Potassium	15- 23
Bicarbonate	372-476
Sulfate	90-148
Chlorides	80-196
Fluoride	1.0-1.4
Nitrate	2.2-3.5

Although this water has a higher concentration of total solids than does the water from the Canyon group, it is still of acceptable quality.

Subarea 4

Subarea 4 is the Fort Worth municipal-industrial complex. Treated and untreated wastes from water users in most of Parker and Tarrant Counties are discharged to the Clear and West Forks of the Trinity River.

The quality of the waters in this subarea as well as all other subareas in the Trinity River down to Rosser, Texas, are clearly described in a comprehensive report by the Texas State Department of Health entitled "Upper Trinity River Sewage and Industrial Wastes Survey."

The West Fork Trinity River upstream from the mouth of Clear Fork Trinity River has "acceptable quality and does not appear to be adversely affected by the discharge of sewage or industrial wastes." Expressed in parts per million, the following quality was found during the year 1959: dissolved solids 299; chlorides 26; sulfates 24; chlorine demand 1.6; dissolved oxygen 6.0; BOD 1.5.

The next eight miles of the West Fork from the mouth of Clear Fork to the city of Fort Worth's Riverside Sewage Treatment Plant is described as follows: "The BOD loading in the West Fork Trinity River is greater below the confluence of the Clear Fork Trinity River than above. ... is of generally acceptable quality with an average BOD of 3.6 ppm. The average BOD in the Clear Fork Trinity River above its confluence with the West Fork Trinity was found to be 5.2 ppm during 1959. On the basis of this investigation, it is concluded that the Clear Fork Trinity River contributes to the deterioration of the water in the West Fork Trinity River."

Degradation of the quality of the West Fork begins with the discharge of Clear Fork water at mile 560. Traveling downstream from Clear Fork, incremental pollution loads are added by the American Cyanamid Company (high sulfate wastes), Marine Creek, Sycamore Creek, and the Riverside Sewage Treatment Plant. The quality of the water in the West Fork immediately downstream from the Fort Worth Riverside Sewage Treatment Plant is of "poor organic quality" as shown in the following average values in ppm for the year 1959:

Analysis	Concentration (ppm)
Dissolved Solids	760
Chloride	109
Sulfate	202
Chlorine Demand	6.7
Dissolved Oxygen	1.0
BOD	7.5

In the reach of the West Fork from the Riverside Sewage Plant at mile 852 to the mouth of the Elm Fork in Dallas, the following cities have sewage treatment plants that discharge effluent: Richland Hills, Hurst, Fort Worth, Euless, Arlington, Keller, and Dallas. The cities of Grand Prairie and Irving dispose of their wastes by treatment at the Trinity River Authority Central Sewage Treatment Plant. Amon Carter Field has a waste treatment plant that discharges effluent to this watershed. The survey showed the following quality at a point upstream from the mouth of Elm Fork, at West Loop 12 (sample point No. 26):

Analysis	Concentration (ppm)
Dissolved Solids	713
Chlorides	109
Sulfates	178
Chlorine Demand	6.6
Dissolved Oxygen	3.1
BOD	7.4

W. O. George (III-2) has the following to say about ground waters in this subarea: "City of Fort Worth only. In 1954, total withdrawals from Tarrant County were about 20,000 acre-feet, of which 8,000 acre-feet were for industry. Concentrated pumpage near Handley caused 100 feet decline in water level in two years. Paluxy, Glen Rose, and Trinity sands yield water of fair quality."

Subarea 2

This is the Elm Fork Trinity River subbasin. The following excerpts are taken from the state's recent pollution survey.

"This investigation is concerned primarily with the Elm Fork Trinity River and tributaries, starting below the Garza Little Elm Reservoir in Denton County and extending downstream to its confluence with the West Fork Trinity River in the western part of Dallas County. This is a distance of approximately 24 miles and includes an area of approximately 238 square miles.

"This survey has disclosed the Elm Fork Trinity River and tributaries to contain water of generally acceptable quality and does not appear to be adversely affected by the discharge of effluent from the sewage treatment plants."

Analysis of the water in Elm Fork just prior to discharging to the Trinity River at mile 506 (average of 1959 state pollution survey) shows:

Analysis	Concentration (ppm)
Dissolved Solids	399
Chlorides	239
Sulfates	51
Chlorine Demand	1.5
Dissolved Oxygen	7.7
BOD	1.2

Ground waters in Subarea 2 are available in the Trinity group, Paluxy sands, Woodbine sands, and some Glen Rose.

The city of Muenster obtains its ground water from the Trinity group. The quality of its water supply is shown here as an indication of quality in that formation in this subarea. A 618-foot deep well had the following quality in 1944:

Analysis	Concentration (ppm)
Dissolved Solids	418
Total Hardness	9
Silica	13
Iron	.02
Calcium	2.4
Magnesium	0.7
Sodium	162
Potassium	3.4
Bicarbonate	375
Sulfate	38
Chloride	12
Fluoride	0
Nitrate	2.0

The city of Collinsville obtains its supply from Paluxy sands. The Collinsville water supply contains 528 ppm total solids, and only 3 ppm hardness.

The city of Prosper obtains its ground water from Woodbine sand. The quality of water obtained from a 619-foot deep well (sample collected April 10, 1942) showed the following:

Analysis	Concentration (ppm)
Total Dissolved Solids	1,780
Total Hardness	51
Silica	14
Iron	1.0
Calcium	12
Magnesium	5
Sodium and Potassium	670
Bicarbonate	927
Sulfate	320
Chloride	295
Fluoride	3.3
Nitrate	0.4

The above analysis shows this water to be excessively high in total dissolved solids, chloride, sulfate, bicarbonate, and sodium.

The city of Carrollton also draws its water from Woodbine sands, and analysis of its water from 320 to 410-foot deep wells shows total dissolved solids at 2,190 and all other analyses proportionately higher than those in the above analysis for Prosper.

Subarea 3

Subarea 3 is the East Fork of the Trinity River. The state pollution survey was concerned primarily with the East Fork Trinity River and its tributaries starting below the Lavon Reservoir and extending downstream to its confluence with the Trinity River at mile 460. This is a distance of approximately 32 miles and includes an area of about 624 square miles. The cities that fall entirely or partially within this area of investigation are: Rosser, Crandall, Forney, Rockwall, Seagoville, Clayburg, Balch Springs, Sunnyvale, Mesquite, Dallas, Rowlett, Richardson, Garland, and Sachse.

The survey showed a total load of 1,822 pounds of BOD per day being added to the East Fork and its tributaries by discharges from sewage treatment plants. Quality at sample point No. 2 just upstream from the point of discharge of the East Fork to the Trinity River at mile 460 in ppm is:

Analysis	Concentration (ppm)
Dissolved Solids	388
Chlorides	69
Sulfates	48
Chlorine Demand	4.5
Dissolved Oxygen	4.4
BOD	4.4

The average discharge for nine years of record was 579 cfs.

Ground waters in Subarea 3 are available in the Trinity, Woodbine, and Paluxy sands.

The city of Gunter obtains its water from a 734-foot deep well into the Woodbine formation. A sample of this water, collected in June, 1953, had the following quality:

Analysis	Concentration (ppm)
Total Solids	810
pH	9.0
Total Alkalinity	600
Silica	33
Total Hardness	48
Calcium	14
Magnesium	3
Sodium	304
Iron	0.09
Sulfate	65
Chloride	28
Fluoride	1.4
Nitrate	0.4

This water, although soft, has a high pH, alkalinity, and sodium content.

The city of Celina draws its water from the Paluxy and Woodbine sands. The water in these sands in Subarea 3 is indicated in the analysis of a sample collected from the Celina distribution system in September, 1951. This water represents a composite of two wells, 740 feet and 1,540 feet deep.

Analysis	Concentration (ppm)
Total Solids	740
pH	8.6
Total Alkalinity	525
Silica	19
Total Hardness	42
Calcium	10
Magnesium	4
Sodium	276
Iron	0.14
Sulfate	74
Chloride	28
Fluoride	1.2
Nitrate	1.3

Subarea 5

Subarea 5 is the Dallas municipal-industrial complex, in which the Trinity River flows from mile 506 to mile 385. While passing through Subarea 5 it receives the discharge from Mountain Creek, Elm Fork, White Rock Creek, and East Fork.

In the reach from Elm Fork to the Dallas plant, the state pollution survey revealed the following information: "A load of 28,270 pounds of BOD per day is placed on this river by discharges of effluent from the Dallas and White Rock sewage treatment plants. An additional BOD loading is placed on this river by the periodic by-passing of raw sewage and various industrial wastes." Average results of the laboratory analyses performed on samples collected during the first nine months of 1959 were as follows:

Analysis	Concentration (ppm)
Dissolved Solids	558
Chlorides	78
Sulfates	128
Chlorine Demand	6.7
Dissolved Oxygen	1.3
BOD	9.0

The average flow for the period of record from 1903 to 1958 was 1,518 cfs.

The quality of water in the Trinity River from the outlets of the Dallas and White Rock sewage treatment plants to mile 451 near Rosser was also studied in the state's pollution survey. This 30 mile reach of river receives sewage treatment plant effluent from the Pleasant Grove sewage treatment plant, the Federal Correctional Institution sewage treatment plant in Seagoville, and the Hutchins sewage treatment plant.

The state pollution survey showed that a load of 1,758 pounds of BOD per day is discharged to this reach of river and tributaries by sewage treatment plant effluent. The effect of this loading as well as other quality related constituents is shown in the average results for the analyses made at sample point No. 1, located at mile 451.

Analysis	Concentration (ppm)
Dissolved Solids	524
Chlorides	73
Sulfates	115
Chlorine Demand	7.4
Dissolved Oxygen	3.1
BOD	12.8

Quality conditions in the Trinity River as it passes through Subareas 4 and 5 are vividly described in the report "Upper Trinity River Sewage and Industrial Waste Survey of the Texas State Department of Health:" "The confluence of Marine Creek, beginning with the West Fork Trinity River, in Fort Worth, and extending downstream to a point near Rosser, Kaufman County, the Trinity River is devoid of oxygen and is unable to accomplish self-stabilization. Oxidation of organic matter is retarded and septic conditions and offensive odors are usually present. The water is turbid and discolored. Sludge banks may be observed at numerous occasions. There is insufficient oxygen for fish life to propagate."

Ground waters in Subarea 5 are available from the Woodbine and Trinity sands. W. O. George (III-2) has the following to say about the ground waters in Subarea 5: "City of Dallas only. Upper and lower Woodbine available in eastern part. Quality upper Woodbine poor. Paluxy and Trinity available in central and western part. Quality of water fair. All sands weak. Trinity sands very deep in eastern Dallas County. Quality of water probably poor. Collin County wells mostly lower Woodbine."

Subarea 6

Subarea 6 is the Richland Creek watershed. At mile 36 on Richland Creek the average discharge during water year 1957-58 was 508 cfs. The average discharge for the preceding nineteen year record was 395 cfs. The Texas Department of Health Quality Monitoring station No. 11 showed (in ppm): total solids from 192 to 552, median 273; chlorides from 12 to 76, median 36; sulfates 29 to 150, median about 50.

Texas Department of Health Quality Monitoring station No. 13 located at mile 14 shows: total solids 186 to 750 ppm, median 420; chlorides 8 to 50 ppm, median about 32; sulfates from 34 to 190 ppm, median about 110.

At mile 14 the average discharge for water year 1957-58 was increased by 944 cfs from Chambers Creek which joins Richland Creek at mile 14. Texas Department of Health station No. 12 is located near this gage. Total solids ranged from 180 to 516 ppm.

A Geological Survey quality station is located at mile 4 on Richland Creek. This station is about four miles downstream from the mouth of Chambers Creek. Dissolved solids varied from 180 to 6,960 ppm; hardness varied from 103 to 326 ppm; chlorides varied from 15 to 4,000 ppm; sulfates ranged from 27 to 154 ppm.

Thus the Richland Creek watershed discharged about 1,452 cfs to the Trinity River at mile 373.

Ground waters in Subarea 6 are available from the Trinity and Woodbine sands. One of the cities that draws its water from the Trinity group is Alvarado, with a 1,677-foot deep well. The quality of water in the distribution system in 1952 was as follows:

Analysis	Concentration (ppm)
Total Solids	788
pH	8.3
Alkalinity	450
Silica	12
Total Hardness	34
Calcium	7
Magnesium	4
Sodium	308
Iron	0.15
Sulfate	185
Chloride	43
Fluoride	2.60
Nitrate	2.7

This water is high in sodium and fluoride.

Italy is one of the cities drawing from the Woodbine sands. The quality of water from a 900-foot well sampled in September, 1953, was as follows:

Analysis	Concentration (ppm)
Total Solids	1,592
pH	8.3
Total Alkalinity	585
Silica	17
Total Hardness	33
Calcium	10
Magnesium	2
Sodium	564
Iron	0.12
Sulfate	494
Chloride	114
Fluoride	4.80

This water is excessive in total solids, alkalinity, sodium, sulfate, and fluoride.

Subarea 7

Subarea 7 is the 1013 square mile drainage area of Cedar Creek. A Geological Survey quality and discharge station is located at mile 31. Available records for water year 1956-57 include the following data:

	Max.	Min.	Ave.
Discharge (cfs)	17,590	0	911
Analyses (ppm)			
Total Dissolved Solids	471	51	76
Chloride	230	5	9.4
Sulfate	69	4	8.7
Hardness	172	17	38

Ground waters in Subarea 7 are available from the Carrizo-Wilcox group. There are no ground water formations within a reasonable distance of Terrell.

The cities of Athens and Malakoff obtain their waters from the Wilcox group. The quality of water for both cities is shown here to indicate the difference in quality at different depths in the same formation.

Analysis	Athens	Malakoff
Depth	1,000 ft.	365 ft.
Total Solids	283	430
pH	8.2	8.6
Total Alkalinity	160	225
Silica	20	18
Total Hardness	36	24
Calcium	11	3
Magnesium	2	4
Sodium	91	165
Iron	0.42	0.09
Sulfate	8	21
Chloride	46	96
Fluoride	0.10	0.2

Subarea 8

Subarea 8 includes the Trinity River from mile 372 to mile 181.

The Geological Survey has maintained a discharge gage at mile 313 since 1923. It operated a chemical quality station at this point from 1947 through 1954. Average discharge for water year 1957-58 was 7,678 cfs. The preceding thirty-five year record showed an average discharge of 4,905 cfs. The weighted mean of chemical analyses for water year 1952-53 at this station was: hardness 120 ppm, chlorides 62 ppm, sulfates 42 ppm, and dissolved solids 303 ppm (2,590 tons per day for the weighted average discharge of 3,164 cfs).

At mile 230 the average discharge for water year 1957-58 was 9,023 cfs. The average discharge for the preceding nineteen years was 6,110 cfs. Texas Department of Health Quality Monitoring station No. 5 showed the following: total solids from 108 to 960 ppm, median 273; chlorides from 16 to 400 ppm, median about 50; sulfates from 15 to 82 ppm, median about 50; BOD ranged from 0.5 to 14.5, with three values rated at 4 ppm (three out of 29 samples).

At mile 182 the average discharge for water year 1957-58 was 10,050 cfs. The average discharge for the preceding thirty-eight years was 6,623 cfs. Quality Monitoring station No. 4 (Texas Department of Health) showed the following analyses: total solids from 144 to 447, median about 318; chlorides from 24 to 120 ppm, median about 60; sulfates from 19 to 71 ppm, median about 40. BOD ranged from 0.5 to 6.3 with two values out of 17 greater than 4.0. This represents the quantity and quality of water passing from Subarea 8 to Subarea 9.

Ground waters in Subarea 8 are available from several different formations as indicated in the description of supplies for the following cities.

The city of Fairfield obtains its water from the Wilcox formation only. Analysis of a composite from two wells 586 and 607 feet deep collected in April, 1952, had the following quality:

Analysis	Concentration (ppm)
Total Solids	230
pH	8.1
Total Alkalinity	115
Silica	48
Total Hardness	57
Calcium	16
Magnesium	4
Sodium	48
Iron	1.4
Sulfate	16
Chloride	21
Fluoride	0.1

Except for being high in iron, this appears to be a good quality water.

The city of Buffalo also obtains its water from the Wilcox group and has a similarly good quality water that is low in iron (0.26 - 0.4).

The city of Centerville obtains its water from the Queen City sand member of the Mount Selman formation. Water from a 355-foot deep well had the following quality in January, 1940.

Analysis	Concentration (ppm)
Total Solids	396
pH	8.1
Total Alkalinity	165
Silica	8
Total Hardness	172
Calcium	44
Magnesium	15
Sodium	78
Iron	.06
Sulfate	125
Chloride	32
Fluoride	0.5

Except for being moderately hard, this appears to be a good quality water.

The city of Madisonville obtains its water from the Yegua formation. Two wells, 1145 and 1185 feet deep, had the following quality respectively when sampled in July, 1956:

Analysis	Concentration (ppm)
Total Solids	237-264
pH	7.4-7.4
Total Alkalinity	100-100
Total Hardness	7-11
Calcium	1-1
Magnesium	1-2
Sodium	59-63
Iron	0.1-0.1
Manganese	0.4-0.4
Sulfate	11-11
Chloride	20-25
Fluoride	0.1-0.1

From the above analyses it is apparent that the waters from the 365 and 1,777 feet depths are of good quality; the 186-foot deep well produced poor quality water from the standpoint of hardness, iron, manganese, and chlorides.

The city of Huntsville obtains its water from the Catahoula sandstone with some from Oakville-Lagarto. The following tabulation shows the quality of water obtained from three wells and the quality after treatment.

Analysis	784 ft. Well	730 ft. Well	680 ft. Well	Treated
Total Solids	502	485	480	480
pH	7.4	7.5	7.2	7.6
Total Alkalinity	270	240	265	250
Silica	48	49	52	54
Total Hardness	305	217	242	64
Calcium	114	82	92	24
Magnesium	5	3	3	1
Sodium	53	80	78	153
Iron	0.6	0.03	0.14	0.08
Sulfate	42	38	34	36
Chloride	75	78	78	78
Fluoride	0.2	0.1	0.2	0.1

Subarea 9

Subarea 9 includes the Trinity River from mile 181 to mile 43.

The Geological Survey has maintained a discharge gage at mile 94 since 1924, and a chemical quality station has been maintained since 1950. The average discharge during water year 1957-58 was 11,690 cfs. The average discharge for the preceding thirty-four year period of record was 7,462 cfs. The quality of this water as recorded in U.S.G.S. Water Supply Paper No. 1573 is: hardness 113 ppm, chlorides 37 ppm, sulfates 31 ppm, and dissolved solids 215 ppm (6,790 tons per day, corresponding to a weighted average flow of 11,690 cfs). This represents the water in the Trinity River passing from Subarea 9 to Subarea 10.

Ground waters in Subarea 9 are available in Sparta sands, the Jackson group, and Catahoula-Oakville-Lagarto.

Water sampled from the two wells of Crockett Sparta sands in 1950 and 1951 had the following quality. Values shown are for 544-foot and 576-foot deep wells, respectively.

Analysis	Concentration (ppm)
Total Solids	228-250
pH	7.5-6.9
Total Alkalinity	60-70
Silica	42-36
Total Hardness	38-62
Calcium	10-15
Magnesium	3-6
Sodium	58-55
Iron	1.60-2.10
Manganese	.04-0.1
Sulfate	46-55
Chloride	39-39
Fluoride	0.1-0.1

This water is treated to remove iron and manganese.

The city of Groveton obtains its water from the Jackson group. A sample of this water collected in June, 1952, from the distribution system (which represents a composite from two wells 467 and 476 feet deep) had the following quality:

Analysis	Concentration (ppm)
Total Solids	1,000
pH	8.2
Total Alkalinity	320
Silica	41
Total Hardness	68
Calcium	19
Magnesium	5
Sodium	324
Iron	0.12
Sulfate	267
Chloride	124
Fluoride	0.4
Nitrate	0.4

This water is soft but has high total solids, sodium, and sulfate concentrations.

Subarea 10

Subarea 10 includes the Trinity River from mile 43 to its mouth in Trinity Bay.

There are no discharge gages in operation in this subarea. A discharge gage operated from 1938-40 showed that discharges below 4,200 cfs could not be computed because of tides affecting the stage discharge relation. Quality stations at miles 40, 21, 3, and at the mouth indicate an increasing affect of tidewater on the quality of the Trinity River in this entire subarea. At mile 40, total solids ranged from 174 to 810 ppm. At mile 21 they ranged from 110 to 3,930 ppm. At mile 3 they ranged from 77 to 11,300 ppm. At the mouth they ranged from 140 to 18,400 ppm.

Ground waters in Subarea 10 are obtained from sands of Goliad-Willis-Lissie. The city of Liberty has three wells 520, 820, and 860 feet in depth. The respective quality of water from these wells is shown in the following table:

Analysis	520 ft. Well	820 ft. Well	860 ft. Well
Total Solids	290	530	508
pH	8.2	7.7	7.8
Total Alkalinity	195	135	145
Silica	12	23	20
Total Hardness	138	247	240
Calcium	47	81	78
Magnesium	5	11	11
Sodium	60	82	80
Iron	2.2	0.1	0.2
Sulfate	4	12	21
Chloride	50	197	174
Fluoride	0.5	0.1	0.3

The water from these wells is hard, and that from the 520-foot well contains excessive amounts of iron.

STATEMENT OF TEXAS DEPARTMENT OF HEALTH REGARDING WATER QUALITY IN THE TRINITY RIVER BASIN*

Total Number of Sample Stations = 31
Total Number of Samples Taken = 1728
Average Samples/Station = 56

Total Samples "Good" ------------------------------ 1003 for 58%
Total Samples "Poor" Organically and Chemically --- 93 for 5%
Total Samples "Poor" Organically Only ------------- 591 for 34%
Total Samples "Poor" Chemically Only -------------- 41 for 3%

Remarks: Obviously, this River Basin has been heavily sampled, partially as a result of a rather extensive study being made on the Upper Trinity Watershed above Rosser. As might be anticipated, the results disclose the major constituent affecting water quality to be of organic origin. In the Upper Trinity Survey Area some 761 samples accounted for 72% of the total "Poor" organically, 61% of the total "Poor" chemically, and 95% of the "Poor" organically and chemically samples of the entire river basin. Aside from the effects of this area, the remainder of the Basin apparently does not reflect sources of major organic or chemical contribution.

*Presented to the U. S. Study Commission - Texas, June 6, 1960.

TABLE T-2

DISCHARGE AND QUALITY STATIONS WITH PERIOD OF RECORD IN THE TRINITY RIVER BASIN

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
1	North Creek	NC14 WF664	837	79	1956-	---	---	---
	West Fork Trinity	660	683	80	1956-	---	17	1957-60
	Bridgeport Reservoir on West Fork	626	1,114	81	1932-	---	---	---
	West Fork Trinity	618	1,147	82	1908-29	---	---	---
	Big Sandy Creek	BS4.4 T610	332	83	1936-	---	---	---
	West Fork Trinity	602	1,729	84	1947-	---	---	---
4	Eagle Mountain Res. on West Fork	583	1,974	85	1934-	---	---	---
	West Fork Trinity	573	2,069	86	1923-34	---	---	---
	Clear Fork	CF23.3 WF559	246	87	1947-	---	---	---
	Benbrook Reservoir	CF15 WF559	433	88	1952-	---	---	---
	Clear Fork	CF10 WF559	435	89	1947-	---	---	---

Table T-2 (Continued)

Area	Stream	River Mile	Drainage Area	U. S. G. S. Discharge Station No. (TBWE)	U. S. G. S. Discharge Period of Record	U. S. G. S. Quality Period of Record	TDH Quality Station No. (TDH)	TDH Quality Period of Record
4	Clear Fork	CF3 WF559	526	90	1924-	1948-52	---	---
	Clear Fork	---	---	---	---	---	38	1957-60
	West Fork Trinity	570±	---	---	---	---	37	1957-60
	West Fork Trinity	567	---	---	---	---	36	1957-60
	West Fork Trinity	559	2,627	91	1920-	---	35	1957-60
	West Fork Trinity	555±	---	---	---	---	34	1957-60
	West Fork Trinity	547	---	---	---	---	33	1957-60
	West Fork Trinity	542	---	---	---	---	32	1957-60
	West Fork Trinity	537	---	---	---	---	31	1957-60
	Village Creek	VC8 WF534	126	92	1925-30	---	---	---
5	West Fork Trinity	528	---	---	---	---	30	1957-60
	West Fork Trinity	515	3,070	93	1925-	---	---	---
	Mountain Creek	M5.5 WF508	273	94	1924-32	---	---	---

Table T-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
5	West Fork Trinity	515	---	---	---	---	27	1957-60
	West Fork Trinity	507±	---	---	---	---	26	1957-60
2	Elm Fork Trinity Subwatershed 6-0	---	.77	95	1956-	---	---	---
	Elm Fork Trinity	EF101	46	96	1956-	---	---	---
	Elm Fork Trinity	EF66	379	97	1949-	---	16	1957-60
	Isle du Bois Creek	I7.3 J6 EF61	262	98	1949-	---	---	---
	Clear Creek	C12 EF53	296	99	1949-	---	---	---
	Elm Fork Trinity	EF49	1,076	100	1924-27	---	---	---
	Lake Dallas on Elm Fork	EF38	1,165	101	1928-57	---	---	---
	Little Elm Creek	LE18 EF38	75.5	102	1956-	---	---	---
	Garza Little Elm Res. on Elm Fork	EF31	1,658	103	1954-	---	---	---
	Elm Fork Trinity	EF27.3	1,671	104	1949-	---	---	---

Table T-2 (Continued)

				U. S. G. S.			TDH Quality	
				Discharge		Quality		
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
2	Denton Creek	D32	409	105	1949-	---	---	---
	Denton Creek	D22	621	106	1923-27 1939-55	---	---	---
	Grapevine Reservoir on Denton Creek	D11.7 EF19	694	107	1952-	---	---	---
	Denton Creek	D6.1 EF19	704	108	1947-	---	---	---
	Elm Fork Trinity	T506 EF18	2,457	109	1907-	---	---	---
5	Elm Fork Trinity	EF3 T506	---	---	---	---	25	1957-60
	Trinity River	504	---	---	---	---	24	1957-60
	Turtle Creek	T503	7.98	110	1951-	---	---	---
	Trinity River	500	6,120	111	1903-	---	---	---
	Trinity River	497	---	---	---	---	23	1957-60
	Trinity River	495	---	---	---	---	22	1957-60
	Trinity River	483	---	---	---	---	21	1957-60

Table T-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
5	Trinity River	475±	---	---	---	---	20	1957-60
3	Honey Creek Subwatershed No. 11 on Trib. of Honey Cr.	---	2.14	112	1952-	---	---	---
	Honey Creek Subwatershed No. 12 on Trib. of Honey Cr.	---	1.26	113	1952-	---	---	---
	Honey Creek	H5.6 EF70	39	114	1951-	---	---	---
	East Fork of Trinity	EF77.3 T460	188	115	1949-	---	---	---
	Sister Grove Creek	SG5	115	116	1949-	---	---	---
	East Fork of Trinity	EF54.9	324	117	1949-53	---	15	1957-60
	Lavon Reservoir on East Fork	EF56	777	118	1954-	---	---	---
	East Fork of Trinity	EF54.9 T460	779	119	1953-	---	---	---
	East Fork of Trinity	EF44 T460	840	120	1923-54	---	---	---

Table T-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
	East Fork Trinity	EF13.8 T460	1,257	121	1949-	---	14	1957-60
	Trinity River	451	8,162	122	1924-25 1938-	1954-57	10	1957-60
	Trinity River	393	---	---	---	---	9	1957-60
7	Cedar Creek	C31 T385	734	123	1938-	1956-57	---	---
	Trinity River	375	---	---	---	---	9	1957-60
6	Pinoak Creek	R41	17.6	124	1956-	---	---	---
	Richland Creek	R36 T372	737	125	1939-	---	11	1957-60
	Chambers Creek	C62	---	---	---	---	13	1957-60
	Chambers Creek	C42 R14 T372	818	126	1924-25	---	---	---
	Chambers Creek	C17	971	127	1939-	---	12	1957-60
	Richland Creek	R4 T372	---	---	---	1956-57	---	---

Table T-2 (Continued)

				U. S. G. S.				
				Discharge		Quality	TDH Quality	
Area	Stream	River Mile	Drainage Area	Station No. (TBWE)	Period of Record	Period of Record	Station No. (TDH)	Period of Record
8	Trinity River	313	12,912	128	1923-	1947-54	7	1957-60
	Trinity River	270	---	---	---	---	6	1957-60
	Trinity River	230	14,484	129	1939-	---	5	1957-60
9	Trinity River	182	15,619	130	1903-06 1923-	---	4	1957-60
	Trinity River	153	---	---	---	---	3	1957-60
	Trinity River	94	17,192	131	1924-	1945-49 1950-57	2	1957-60
	Trinity River	40	17,539	---	1938-40	---	1	1957-60
10	Trinity River	21	---	---	---	1949-57	---	---
	Old River of Trinity	OR12$^{\pm}$ T3	---	---	---	1949-57	---	---
	Trinity at Anahuac	0	---	---	---	1949-57	---	---
	Trinity at mouth and bay	0	---	---	---	1950-57	---	---

Table T-2a (Continued

Tri-20	Dallas County	Dowdy Ferry Road, Dallas, West Fork Trinity
Tri-21	Dallas County	Loop 12 SE Dallas on West Fork Trinity
Tri-22	Dallas County	South Central Expressway Dallas, West Fork Trinity
Tri-23	Dallas County	Forrest Avenue Bridge, Dallas, West Fork Trinity
Tri-24	Dallas County	Westmoreland Bridge, Dallas, West Fork Trinity
Tri-25	Dallas County	Gravwyler Road, Dallas, Elm Fork Trinity
Tri-26	Dallas County	Old Singleton Road, Dallas, West Fork Trinity
Tri-27	Dallas County	W. Beltline Road, Dallas, West Fork Trinity
Tri-30	Tarrant County	Bridge, F.M. 157, Fort Worth, West Fork Trinity
Tri-31	Tarrant County	Randall Mill-Hurst Road, Fort Worth, West Fork Trinity
Tri-32	Tarrant County	Ederville Road, Fort Worth, West Fork Trinity
Tri-33	Tarrant County	Bridge, E First St., Fort Worth, West Fork Trinity
Tri-34	Tarrant County	NE 12th Street, Fort Worth, West Fork Trinity
Tri-35	Tarrant County	Bridge - North Main, Fort Worth, West Fork Trinity
Tri-36	Tarrant County	White Settlement Road, Fort Worth, West Fork Trinity
Tri-37	Tarrant County	Fort Worth, Temp Convair-Carswell Outfall (Discontinued)
Tri-38	Tarrant County	Henderson St. Bridge, Fort Worth, Clear Fork of Trinity River

TABLE T-2a

LOCATION OF TEXAS DEPARTMENT OF HEALTH QUALITY MONITORING STATIONS IN THE TRINITY RIVER BASIN

Tri-1	Liberty County	Bridge, U.S. Hwy. 90 at Liberty (No.48)
Tri-2	Liberty County	Bridge, State Hwy. 105 SW Romayer (No.47)
Tri-3	San Jacinto County	Bridge, U.S. Hwy. 190 E Point Blank
Tri-4	Walker County	Bridge, State Hwy. 45 at Riverside (No.46)
Tri-5	Madison County	Bridge, State Hwy. 21 NE Midway (No.45)
Tri-6	Houston County	Bridge, State Hwy. 7 W Crockett
Tri-7	Anderson County	Bridge, U.S.Hwy. 79 W Palestine (No.44)
Tri-8	Anderson County	Bridge, U.S. Hwy. 287 NW Cayuga
Tri-9	Henderson County	Bridge, State Hwy. 31 at Trinidad
Tri-10	Kaufman County	Bridge, State Hwy. 34 near Rosser (No.39)
Tri-11	Navarro County	Bridge, U.S.Hwy. 75 N Richland at Richland Creek(No. 43)
Tri-12	Navarro County	Bridge, State Hwy. 31 E Corsicana at Chambers Creek (No. 41)
Tri-13	Ellis County	Bridge, U.S. Hwy. 77 near Italy on Chambers Creek
Tri-14	Kaufman County	Bridge, U.S. Hwy. 175 W Crandall on East Fork Trinity River (No. 38)
Tri-15	Collin County	Bridge, State Hwy. 78 W Lavon on East Fork Trinity River (No. 36)
Tri-16	Denton County	Bridge, F.M. 455 NE Sanger on Elm Fork Trinity River (No. 16)
Tri-17	Jack County	Bridge, State Hwy. 24 NE Jackson on West Fork Trinity River (No. 2)

TABLE T-3

MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL
TRINITY RIVER BASIN

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
TRINITY RIVER									
WEST FORK	T505.5 = WF505.5								
CARROLLS CREEK	WF642								
Jacksboro	C-10	4,200	Drilled Wells & Lake	0.289	2,000	Loss Creek	437	202	437
Bridgeport	618	2,600	WFTRID	0.234	2,000	West Fork of Trinity R.	220	---	192
BIG SANDY CREEK	610								
PRAIRIE BRANCH									
Chico		480	Well	0.03	---	---	426	426	426
Boyd		430	3 Wells	0.086	---	---	4452	1506	---
Subarea 4									
Newark		285	3 Wells	0.009	---	---	---	---	---
ASH CREEK									

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
Azle		2,800	4 Wells	0.24	---	---	---	---	---
CLEAR FORK	WF558								
Benbrook	CF11	1,540	5 Wells	0.06	2,000	Clear Fork & Trinity	---	---	---
Fort Worth	WF548 to WF570	391,900	Lake Worth	42.0	270,000	West Fork of Trinity	220	220	222
FOSSIL CREEK	WF543								
Watauga		280	Well	0.007		---	---	---	---
VILLAGE CREEK	WF534								
Joshua		900	3 Wells	0.07	---	---	---	---	---
Burleson		1,780	3 Wells	0.12	2,000	Village Creek	535	---	511
Crowley		550	2 Wells	0.035	---	---	---	---	---
Everman		1,000	3 Wells	0.04	---	---	---	---	---
Kennedale		1,150	2 Wells	0.11	---	---	634	634	634
TRIBUTARY OF WEST FORK									
Smithfield		950	Tarrant Ut. Co.	---	---	---	---	---	---
		7,500	11 Wells	1.95					

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
TRIBUTARY OF WEST FORK									
Arlington		17,600	Lake Arlington	1.54	42,000	West Fork	1355	750	922
		26,400	12 Wells	2.21		West Fork			
Subarea 5									
TRIBUTARY OF WEST FORK									
Grand Prairie		15,000 15,000	8 Wells Dallas	--- ---	15,700	Trinity R.	900	542	802
BEAR CREEK									
Keller		800	3 Art. Wells	0.065	---	---	526	496	520
Grapevine		3,200	3 Wells	0.27	2,500	Creek to Grapevine Reservoir	1130	1120	1110
MOUNTAIN CREEK	WF508								
WALNUT CREEK									
Mansfield		1,575	3 Wells	0.045	980	Walnut Creek	---	---	---

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
Subarea 2									
ELM FORK	T505.5								
St. Jo		1,200	3 Wells	0.10	800	Elm Fork	940	500	785
TRIBUTARY OF ELM FORK									
Muenster		1,200	3 Wells	0.12	600	Elm Fork	440	416	415
Gainesville	EF86	15,700	8 Wells	2.0	14,000	Elm Fork	597	455	493
SPRING CREEK									
Valley View		545	2 Wells	0.05	---	---	424	424	424
JORDAN CREEK	EF-70								
Collinville		690	Well	---	---	---	520	518	---
BUCK CREEK									
Tioga		380	Well	0.042	335	Jordan Creek	230	230	230
Pilot Point		1,650	3 Wells	0.18	1,000	Jordan Creek	726	530	---
CLEAR CREEK									
Sanger		1,325	4 Wells	0.10	700	Clear Creek	---	---	---

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
LITTLE ELM CREEK	EF38								
TRIBUTARY OF LITTLE ELM									
Prosper		360	Well	---	---	---	1908	---	1835
HICKORY CREEK	EF30								
Krum		320	3 Wells	0.18	---	---	674	520	---
Denton		28,000	11 Wells & Garza Little Elm	3.0	24,000	Pecan to Hickory	680	545	---
STEWART CREEK	EF28								
Frisco		900	2 Wells	0.052	460	Stewart Cr. to Elm Fork	---	---	762
Lewisville		2,000	3 Wells	0.16	2,500	Creek to Elm Fork	1270	620	---
Subarea 1									
DENTON CREEK	EF18								
BRUSHY CREEK	D-66								
Bowie	B-20	4,800	Lake & Wells	0.40	4,300	Brushy Creek	238	238	238
TRIBUTARY OF DENTON CREEK									

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
		Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
Subarea 2									
Decatur		3,300	8 Wells	0.30	1,520	Sandy Creek & Land Irr.	353	322	---
Ponder		180	Well	0.01	---	---	---	---	---
Justin		730	2 Wells	0.03	350	Creek to Grapevine Reservoir	---	---	---
Roanoke	DC30	760	2 Wells	0.04	---	---	---	---	538
Coppell		300	Well	---	---	---	---	---	---
Carrollton		4,000	3 Wells	---	3,000	Trib. to Elm Fork of Trinity River	2140	955	1252
Subarea 3									
Farmers Branch		9,800	Well	---	---	Trinity River	1610	1610	1610
Vickery		1,200	Dallas	---	---	---	1618	1618	1618
Irving		17,000	8 Wells	1.5	36,000	West Fork	1612	962	1080
WHITE ROCK CREEK	T493								
Addison		400	Well	---	---	---	---	---	---

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Disposal to	Max. ppm	Min. ppm	System ppm
Dallas	T487 to T505	670,000	Wells & 5 Lakes	71.5	483,700	Trinity and the East Fork	1298	127	---
Hutchins	T483	7,000	2 Wells	0.05	700	Creek to Trinity	---	---	---
TRIBUTARY OF TRINITY									
Kleburg		2,870	Well	---	---	---	---	---	---
TEN MILE CREEK	T471								
Duncanville		3,500	3 Wells	---	---	Creek to Trinity	1062	1062	1062
Lancaster		5,800	3 Wells	---	2,270	Ten Mile Creek	1402	1262	---
Wilmer		1,550	Well	---	---	---	3188	---	3182
RED OAK CREEK									
Cedar Hill		2,500	3 Wells	---	800	Creek to Trinity	---	---	865
Red Oak		300	Well	0.072	---	---	1244	1244	1244
Palmer		830	Well	---	470	Red Oak Creek	---	---	2065

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge to	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
Subarea 3									
EAST FORK	T460								
Dorchester		75	Well	---	---	---	---	---	---
Gunter		630	Well	---	---	---	810	810	810
Van Alstyne		1,860	2 Wells	---	1,100	Sister Grove Creek	3279	445	552
Weston		115	Well	---	---	---	---	---	---
Anna		500	Well	---	---	---	---	---	3654
HONEY CREEK									
WILSON CREEK									
Celina		1,600	2 Wells	---	785	Wilson Creek	730	605	740
McKinney		13,200	NTMWD	---	6,000	Wilson Creek to Lavon Reservoir	1328	1084	1215
PILOT GROVE CREEK	EF51								
Blue Ridge		475	Well	0.056	---	---	568	568	568
SISTER GROVE CREEK									
Westminster		110	Well	---	---	---	---	---	---

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Source	Use mgd	Waste Disposal Population Served 1957	Discharge to	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
TICKY CREEK									
Melissa		375	Well	---	---	---	3010	3010	3010
Princeton		760	Well	0.05	---	---	904	904	904
Rockwall	EF44	2,400	NTMWD	---	1,260	White Oak Creek	3835	925	908
MUDDY CREEK	EF34								
Wylie		1,928	NTMWD	---	1,000	Muddy Creek	822	822	822
TRIBUTARY OF MUDDY CREEK									
Allen		640	Well	---	---	---	---	---	1177
Plano		3,600	NTMWD	---	2,250	Rowlett Creek	2155	2090	---
Rowlett		320	Well	---	---	---	---	---	---
DUCK CREEK	EF31								
Richardson		10,205	2 Wells	---	1,240	White Rock Cr.	1105	780	---
Garland		30,000	NTMWD	13.0	23,000	Duck Creek to East Fork	1202	870	---
TRIBUTARY OF EAST FORK									
Mesquite		19,400	NTMWD	---	13,000	South Mesquite Creek	2134	1000	---

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge to	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
BUFFALO CREEK	EF7								
Forney		1,750	NTMWD	---	1,180	Buffalo Creek	2640	1000	2566
Seagoville		4,160	2 Wells	---	1,000	Parsons Slough	2500	2435	---
TRIBUTARY OF EAST FORK									
Crandall		735	2 Wells	.012	400	Buffalo Creek	3480	3480	3480
VILLAGE CREEK	T437								
TRIBUTARY OF VILLAGE CREEK									
Subarea 7									
Ennis		9,180	3 Wells	0.80	6,500	Cummings Creek	2256	2208	2200
Trinidad	T392	825	Lake & Well	0.065	---	---	---	---	---
RUSH CREEK	T388								
Kerens		1,850	Lake	0.15	920	Rush Creek	175	---	122
CEDAR CREEK	T386								

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge to	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
KINGS FORK	C54								
Terrell	K-16	14,300	7 Wells & Lake	1.07	10,230	Kings Fork	93	---	160
Kaufman	K-4	3,630	Lake	0.25	2,250	Kings Fork	211	164	---
Kemp	C-43	1,190	Lake	0.125	1,050	Cedar Creek	180	---	210
LACYS FORK	C-35								
Mabank	La-3	1,335	Lake	0.10	630	Lacys Fork	384	70	450
PURTIS CREEK									
Eustace		380	3 Wells	0.04	---	---	---	---	---
TRIBUTARY OF CEDAR CREEK									
Athens		7,025	4 Wells	0.716	6,000	Cedar Creek	283	210	266
Malakoff		1,250	2 Wells	---	---	---	430	430	430

Subarea 6

RICHLAND CREEK	T373								
CHAMBERS CREEK	R14								

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
ONION CREEK	C43								
Forreston		175	Well	0.015	---	---	1770	1770	1770
WAXAHACHIE CREEK	C42								
Midlothian		2,115	3 Wells	---	950	Mountain Creek	970	800	---
Waxahachie	Wa-23	13,410	Lake & Wells	0.600	7,500	Waxahachie Cr.	1185	940	---
TRIBUTARY OF WAXAHACHIE CREEK									
Boyce		110	Well	0.001	---	---	---	---	---
NORTH FORK									
Keene		1,000	2 Wells	0.09	450	Dry Creek to North Fork of Chambers Cr.	583	550	---
Venus		350	Well	0.03	300	Dry Creek	834	834	834
Alvarado		1,845	2 Wells	0.20	1,000	North Fork of Chambers Cr.	---	---	---
Maypearl		530	2 Wells	---	300	North Fork of Chambers Cr.	---	---	---

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Source	Use mgd	Waste Disposal Population Served 1957	Discharge to	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
SOUTH FORK									
Grandview		886	4 Wells	0.20	500	South Island Creek	880	540	---
Italy		1,570	2 Wells	---	850	Chambers Cr.	1592	---	1570
MILLER CREEK									
Milford		945	Well	---	550	Mill Creek	---	---	---
TRIBUTARY OF CHAMBERS									
Emhouse		230	Well	0.015	---	---	---	---	---
Corsicana	Ch-22	25,000	2 lakes	2.25	28,900	Chambers Cr.	420	---	386
Mertens	---	200	Well	0.01	---	---	---	---	1,620
WHITE ROCK CREEK									
Brandon	---	146	Well	0.03	---	---	---	---	---
Irene	---	250	Well	0.02	---	---	---	---	2,315
ASH CREEK									
Bynum	---	330	Well	0.02	---	---	---	---	---

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge To	Max. ppm	Min. ppm	System ppm
Malone	---	365	Wells (Artesian)	0.025	300	Ash Creek	---	---	3,560
POSTOAK CREEK									
Frost	---	745	Well	0.06	450	Mill to Chambers	---	---	242
TRIBUTARY									
Dawson	---	990	Lake	0.075	635	Trib. to Trinity	292	---	---
Purdon	---	---	Well	0.015	---	---	---	---	---
BRIER CREEK									
Barry	---	180	Well	0.005	---	---	---	---	---
PINOAK CREEK									
Hubbard	---	1,700	2 Wells	0.10	1,000	Pinoak Creek	---	---	---
TRIBUTARY									
Coolidge	---	1,155	Lake	0.095	600	Pinoak Creek	275	---	148
Tehuacana	---	375	Well & Spring	0.03	---	---	440	440	440
Richland (hills)	---	7,600	9 Wells	1.40	5,000	Creek to West Fork	---	---	---

TABLE T-3 (Continued)

		Water Supply			Waste Disposal		Total Dissolved Solids in Source of Public System		
Name and Location	River Mile	Population Served 1957	Source	Use mgd	Population Served 1957	Discharge to	Max. ppm	Min. ppm	System ppm
Subarea 8									
TEHUACANA CREEK	T-347								
Wortham	Te-36	1,425	Lake	0.045	670	Wolf Cr.	164	158	217
Streetman	---	530	Lake	---	---	---	300	---	135
CANEY CREEK	Te-22								
Teague	Ca-18	4,810	Lake	---	1,530	Caney Creek	107	----	164
COTTONWOOD CREEK									
Fairfield	---	1,800	Deep Well	0.142	1,180	Walnut Cr.	246	191	230
BOX CREEK	T-294								
Elkhart	---	776	2 Wells	---	420	Box Cr. to Trinity	294	294	294
UPPER KEECHI CREEK	T-273								
BUFFALO CREEK									
Buffalo	---	1,250	2 Wells	0.14	750	Buffalo Cr.	201	200	---
ELKHART CREEK	T-272								
Grapeland	---	1,300	2 Wells	0.16	1,300	Cr. to Trib. of Trinity	705	333	---

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Water Supply Source	Water Supply Use mgd	Waste Disposal Population Served 1957	Waste Disposal Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Total Dissolved Solids in Source of Public System Min. ppm	Total Dissolved Solids in Source of Public System System ppm
LOWER KEECHI CREEK	T-241								
Jewett	---	600	Well	0.10	---	---	218	210	---
Centerville	---	1,200	2 Wells	0.108	900	Lower Keechi	396	396	413
Midway	---	200	Well	0.015	---	---	566	566	566
BEDIAS CREEK	T-208								
Iola	---	400	2 Wells	0.02	---	---	1,122	792	---
CANEY CREEK									
Madisonville	---	2,700	2 Wells	0.20	2,100	Town Br. to Caney Cr.	874	150	---
SOUTH BEDIAS CREEK									
Bedias	---	500	Well	0.05	---	---	1,295	899	---
NELSON CREEK	T-199								
Huntsville	---	9,000	4 Deep Wells	1 097	6,900	Herman Cr.	502	480	480

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply Population Served 1957	Source	Use mgd	Waste Disposal Population Served 1957	Discharge To	Total Dissolved Solids in Source of Public System Max. ppm	Min. ppm	System ppm
Subarea 9									
Riverside	T-183	4,200	6 Wells	0.45	---	---	---	---	---
WHITE ROCK CREEK	T-170								
GAIL CREEK									
Crockett	---	6,500	3 Deep Wells	0.50	4,000	Gail Cr.	250	228	285
TANOBOGUE CREEK									
Lovelady	---	540	Well	0.06	200	Tanoboque Cr.	705	705	705
KICKAPOO CREEK	T-156								
Groveton	---	1,000	2 Deep Wells	0.10	1,000	Kickapoo Cr.	1,000	1,000	1,000
Onalaska	---	100	Well	---	---	---	---	---	---
LONG KING CREEK	T-118								
TRIBUTARY									
New Willard	---	400	2 Wells	---	---	---	---	---	---

TABLE T-3 (Continued)

Name and Location	River Mile	Water Supply: Population Served 1957	Water Supply: Source	Water Supply: Use mgd	Waste Disposal: Population Served 1957	Waste Disposal: Discharge To	Total Dissolved Solids in Source of Public System: Max. ppm	Min. ppm	System ppm
Livingston	---	5,000	2 Wells Creek	0.313	2,000	Long King Cr.	449	440	166
Goodrich	---	300	Well	0.012	---	---	298	298	298
BIG CREEK	T-98								
Cold Spring	---	300	Spring	---	---	---	---	---	---
Shepherd	---	350	San Jacinto Co. WCID #1	---	---	---	---	---	---
Liberty	T-40	6,000	2 Wells	0.51	5,000	Trinity	530	290	---
Dayton	T-40	2,500	2 Wells	0.23	1,020	Trinity	660	565	566

TABLE T-4

SALINE GROUND WATERS IN THE TRINITY RIVER BASIN

Area	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
1 - West Fork	C3	Wise	781	61	1,600	Penn. undifferentiated	---	---	Thompson Creek
3 - East Fork	K74	Collin	371	205	1,260	Trinity Group	P	99	Wilson Cr.
	K113	Rockwall	43	1,730	3,840	Woodbine Sand	P	---	East Fork
	K114	Collin	425	378	2,010	Woodbine Sand	P	85	Creek
	K115	Collin	800	1,180	3,750	Woodbine Sand	P	---	Sister Grove Cr.
	K116	Collin	13	1,270	2,850	Woodbine Sand	P	---	Sister Grove Cr.
	K117	Collin	654	660	2,800	Woodbine Sand	P	---	Sister Grove Cr.
4 - Clear Fork	C4	Parker	774	418	2,320	Penn. undifferentiated	S	---	Willow Cr.
West Fork	K10	Tarrant	106	250	1,200	Travis Peak Formation	---	---	West Fork
Clear Fork	K37	Parker	167	815	1,870	Paluxy Sand	D	---	Clear Fork
	K38	Parker	354	132	1,180	Paluxy Sand	D, S	---	Willow Cr.

*D, domestic; S, stock; Ind, industrial; Irr, irrigation; P, public supply; N, none.

TABLE T-4 (Continued)

	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. ^{o}F	Nearest Stream
4 - West Fork	K73	Tarrant	91	129	1,040	Trinity Group	---	---	West Fork
	K108	Tarrant	1,960	258	3,510	Woodbine Sand	---	---	West Fork
5 - Trinity River	K11	Dallas	253	94	1,030	Travis Peak Formation	P	115	Five Mile Creek
	K12	Dallas	4,740	293	7,470	Travis Peak Formation	---	---	White Rock Creek
	K13	Dallas	279	88	1,040	Travis Peak Formation	P	---	Trinity R.
	K14	Dallas	341	80	1,090	Travis Peak Formation	P	104	Trinity R.
	K34	Dallas	1,190	137	2,500	Paluxy Sand	---	119	Trinity R.
	K35	Dallas	510	91	1,510	Paluxy Sand	---	---	Trinity R.
	K36	Dallas	466	80	1,390	Paluxy Sand	---	114	Trinity R.
East Fork	K109	Dallas	307	63	1,060	Woodbine Sand	P	---	Creek
Trinity River	K110	Dallas	498	185	1,680	Woodbine Sand	Ind	85	Trinity R.
6 - Chambers Creek	K70	Ellis	683	40	1,400	Trinity Group	P	---	Mill Cr.
	K71	Ellis	245	110	1,010	Trinity Group	P	---	Waxahachie Creek

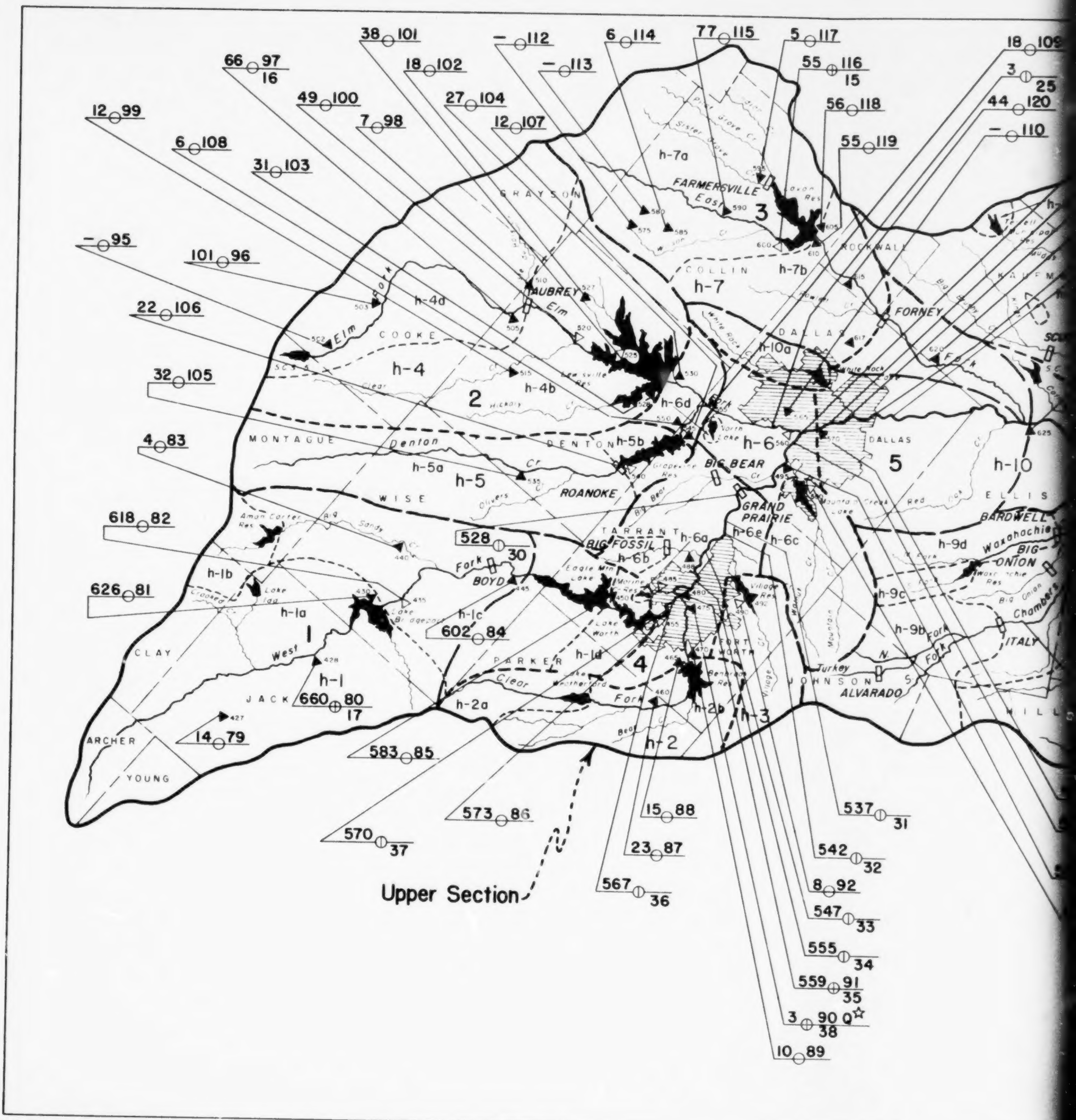
TABLE T-4 (Continued)

	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
6 - Chambers Creek	K100	Navarro	153	1,790	4,550	Woodbine Sand	P	---	Chambers Creek
	K101	Navarro	491	612	2,740	Woodbine Sand	P	---	Creek
Richland Creek	K102	Navarro	441	131	1,600	Woodbine Sand	P	92	Postoak Cr.
	K103	Navarro	172	760	2,550	Woodbine Sand	P	---	Creek
Trinity River	K104	Ellis	337	126	1,380	Woodbine Sand	P	---	Creek
Chambers Creek	K105	Ellis	501	195	1,750	Woodbine Sand	P	---	Onion Cr.
Trinity River	K106	Ellis	500	285	2,140	Woodbine Sand	P	---	Village Cr.
	K107	Ellis	488	277	2,060	Woodbine Sand	P	---	Village Cr.
7 - East Fork	K111	Kaufman	269	1,210	3,470	Woodbine Sand	P	95	Creek
	K112	Kaufman	453	548	2,570	Woodbine Sand	P	100	Buffalo Creek
8 - Trinity River	E82	Walker	293	348	1,180	Jackson Group	P, Ind	77½	Harmon Cr.
	E83	Walker	1	435	1,250	Jackson Group	S	---	Harmon Cr.
9 - Trinity River	M17	Walker	996	372	2,150	Catahoula Sandstone	D, Ind	77½	Harmon Cr.

TABLE T-4 (Continued)

	Well No.	County	SO_4 ppm	Cl ppm	TDS ppm	Water Bearing Unit	Use of Water*	Temp. °F	Nearest Stream
9 - Trinity River	M18	Polk	2	470	1,100	Catahoula Sandstone	S	70	Trinity R.
	M19	Polk	2	970	2,060	Catahoula Sandstone	D, S	---	Trinity R.
10 - Trinity River	O60	Liberty	4	550	1,140	Goliad Sand	Irr	---	Trinity R.
	O61	Liberty	12	560	1,140	Goliad Sand	Irr	78	Trinity R.
11 - Tidewater	B18	Chambers	1	275	1,100	Beaumont Clay	---	---	Creek
	B19	Chambers	1	762	1,730	Beaumont Clay	---	---	Tidewater
	B20	Chambers	4	1,000	2,040	Beaumont Clay	---	---	Tidewater
	B21	Chambers	68	275	1,060	Beaumont Clay	---	---	Tidewater

A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PARKER
JACK
CLAY
ARCHER
YOUNG
HILL
FARMERSVILLE
AUBREY
FORNEY
ROANOKE
BIG BEAR
GRAND PRAIRIE
BIG FOSSIL
BOYD
BARDWELL
BIG ONION
ALVARADO
ITALY
FORT WORTH
Waxahachie
Chambers
Lewisville Res
Lake Worth
Eagle Mtn Lake
Lake Bridgeport
Lake Weatherford
Benbrook Res
Village Res
Grapevine Res
North Lake
White Rock
Lavon Res
Amon Carter Res
Mountain Creek Lake
Terrell
Elm
Clear
Hickory
Denton
Oliver's
Big Sandy
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Clear Fork
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Wilson
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Sister Grove
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U S STUDY COMMISSION-TEXAS T 55

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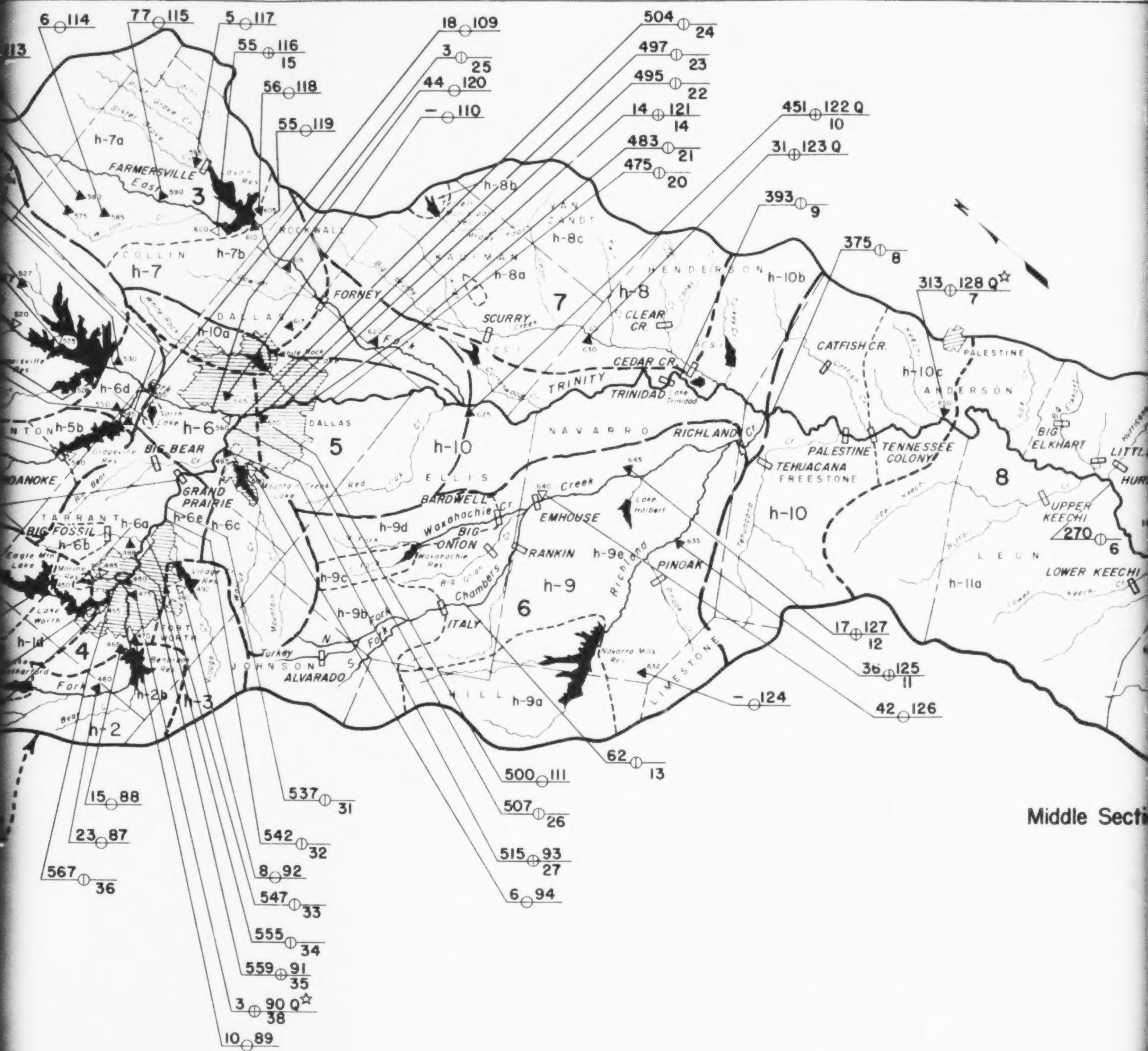

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LIMESTONE

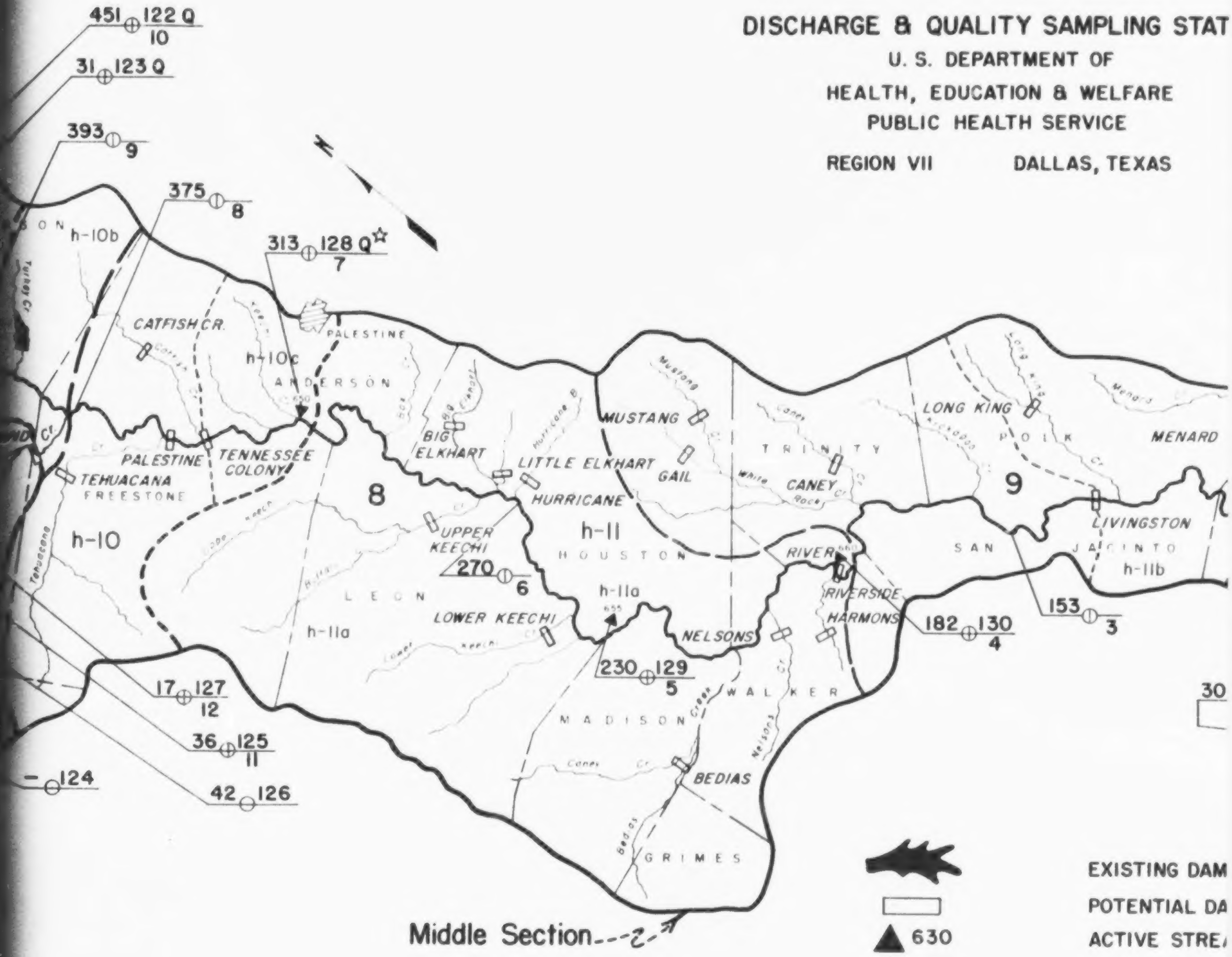
Middle Secti

C

TRINITY RIVER BASIN

DISCHARGE & QUALITY SAMPLING STAT

U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS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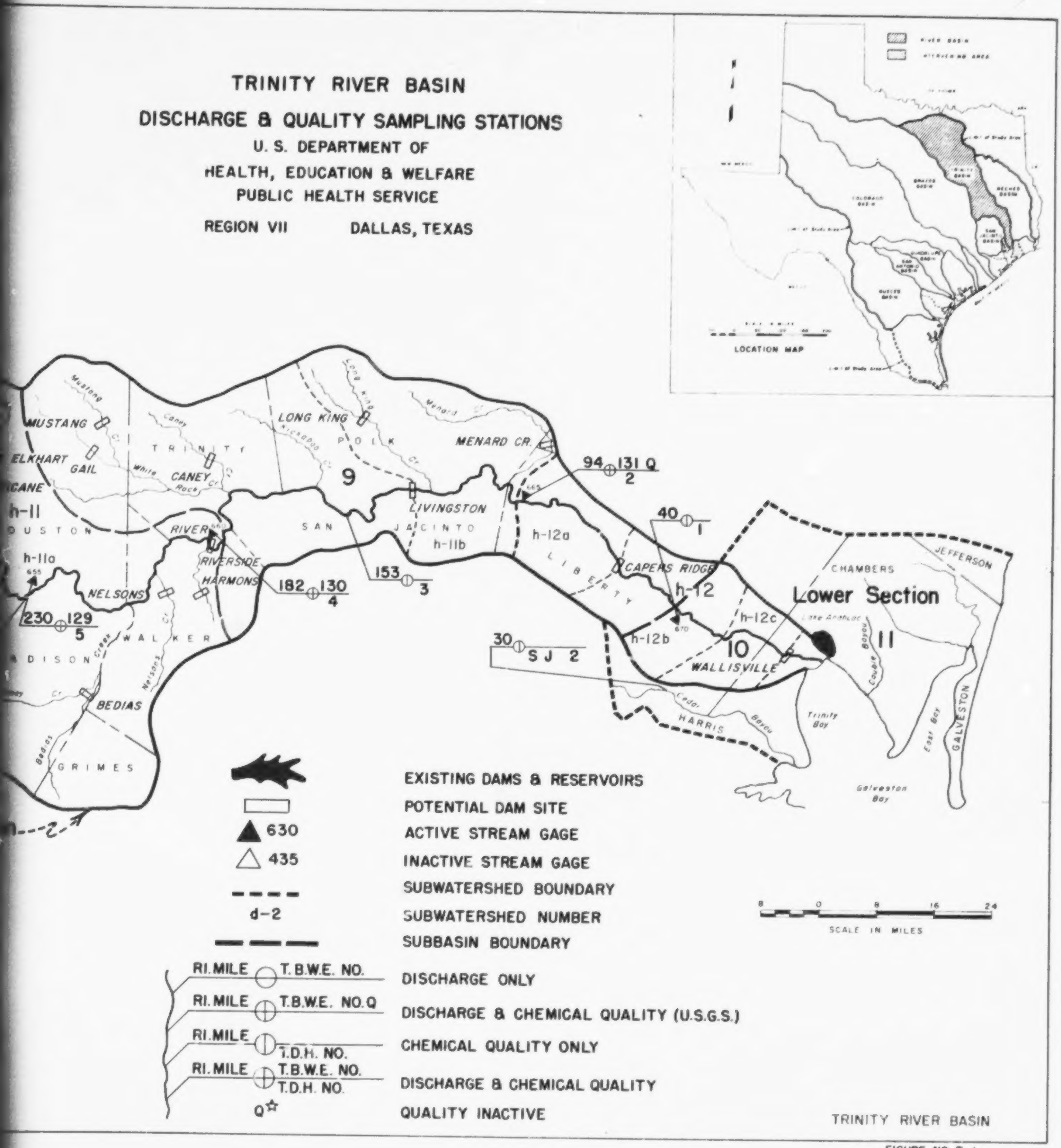
D

TRINITY RIVER BASIN

DISCHARGE & QUALITY SAMPLING STATIONS

U. S. DEPARTMENT OF
HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS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HOUSTON
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HARMONS
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WALLISVILLE
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CHAMBERS
JEFFERSON
Lower Section
Lake Anahuac
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Double Bayou
Trinity Bay
East Bay
GALVESTON
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Cedar Bayou
HARRIS
MADISON
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Nelsons Cr.
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GRIMES
2
EXISTING DAMS & RESERVOIRS
POTENTIAL DAM SITE
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SCALE IN MILES
TRINITY RIVER BASIN

FIGURE NO. T-1

WATER QUALITY CRITERIA

There is no universally "good" or "poor" quality water; classification depends on the specific use to be made of it. Even pure water might be classified as poor quality from the standpoint that it would be corrosive in distribution mains.

In order to expedite planning, Item 2 of the Work Assignment was developed as a priority item. The U. S. Public Health Service developed Water Quality Criteria in cooperation with the Texas State Department of Health and others. The Criteria which follows was adopted by the Commission on May 2, 1960, as the basis of planning:

"It is realized that the population and industrial increases in the future will result in an increasing demand for water with the ultimate necessity for re-use of waste water. To many in the State of Texas, the necessity for re-use of waste water will be accepted with reluctance. However, it appears that increased development of the State will involve utilization of all available sources of water including waste water.

"Planning a complete water use program for the State of Texas necessitates the application of water quality limits. This does not mean, however, that the State must tolerate inferior quality waters as the price of economic growth. Those using the waters of the State for ultimate disposal of liquid waste have a public responsibility to take all reasonable actions to assure that its potential for use by others downstream is not impaired.

"In order to assure maximum utilization of available surface waters, the following criteria should prevail:

a. No excessive bacterial or radiological contamination;
b. No excessive deposits in the streams;
c. No concentration of any chemical, chemical compound or combinations thereof which interferes with any legitimate downstream use;
d. No objectionable floating materials.

"The objective for the future is to maintain the best quality of water possible. Realizing that water re-use generally will tend to result in some degradation of water quality, the following guide lines as to limiting concentrations in the water course are used only for the purpose of planning.

Coliform Bacteria (MPN/100 ml)	1000 or less
Dissolved Oxygen	Not less than 4.0 ppm
pH	6.0 to 8.5
Total Dissolved Solids	1000 ppm or less
Chlorides	250 ppm or less
Sulfates	250 ppm or less

Color	20 or less
Iron	0.5 ppm or less
Manganese	0.1 ppm or less
Phenol	0.005 ppm or less
Fluorides	1.0 ppm or less
Boron	0.5 ppm or less
Nitrate	20 ppm or less

"The above list is not intended to be complete. Other guidelines will be applied as they become established. The criteria are considered to be sufficiently flexible to safeguard the downstream users and at the same time recognize the need for the upstream users to dispose of treated wastes.

"Industrial water quality specifications are so varied that it is not practical to set limits for all requirements. There are also other water quality limitations of significance to agriculture which are not specified, but in nearly all cases surface waters which meet these criteria will be satisfactory for agricultural purposes.

"In applying these criteria for the purposes of this study, it is assumed that:

1. Municipal wastes will be treated to remove at least 90% of the putrescible organic material as measured by the 5 day BOD test.

2. Organic industrial wastes will be treated to provide an effluent of a quality equivalent to treated municipal wastes as in item one above.

3. Inorganic wastes will be treated to reduce the concentration to acceptable limits. Wastes for which satisfactory treatment methods are not known will not be discharged to a watercourse.

4. Discharges of cooling water and wastes will not be permitted to cause a detrimental increase in the temperature of the receiving water."

Water is considered to be of good quality in this report if it meets the above Criteria.

IMPROVEMENT OF WATER QUALITY

Introduction

Before a discussion of the means of improving water quality can be presented, a need for such improvement must be indicated. This can only be stated in terms of the use to which the water is to be applied. A wide range of quality requirements exist in each of the major uses: Municipal requirements include a high degree of bacterial purity and a relatively low hardness to satisfy its domestic and commercial customers. Industrial requirements have the widest range of quality requirements in that certain organic process waters must be ultra pure, while cooling and quenching waters have only a temperature limitation on quality tolerance. Agricultural requirements vary with the specific stock and crop. Recreation requirements vary with the specific activity, from swimming to fishing and boating. Navigation has the least demands on quality, but even this use requires a water that is at least noncorrosive. The stream itself has certain demands for good quality, in order to maintain a healthy ecology.

This discussion of the means of improving water quality will be based on four quality-pertinent areas: (1) the source of quality degradation; (2) the quality improvement of this degraded water at the source; (3) the improvement of water quality in the stream; and (4) improvement of water quality just prior to use. These are shown schematically in Figure I-1.

Water Quality Degradation

1. Effects of natural phenomenon on water quality

The only pure water that exists in nature is in the vapor phase. A nucleus is needed upon which this vapor can condense to form a raindrop. Products of combustion, oxides of nitrogen, and salt crystals are the principle types of condensation nuclei. Thus, the water quality in raindrops reflects the composition of wind-carried dusts or evaporated ocean sprays.

The impact of falling raindrops breaks down clods and aggregrates into a single-grained soil structure. The fine particles are thrown into suspension by the energy of the falling drops and are carried along with the overland flow toward established channels. The flowing water tends to loosen additional particles, and they too may be transported to the stream channel. The resulting suspended sediment is the most readily apparent evidence of quality degradation by natural pollution.

A less common, but nevertheless real, degradation of quality occur when rainwaters flush out extensive swamps laden with decayed leaves and vegetation. Color is the major quality constituent of these waters.

Dissolved solids, especially chlorides and sulfate, reflect the type of terrain and geologic formation that water has passed over or percolated through. Salt domes, springs, or flats cause considerable degradation of water quality in local areas, as in several tributaries of the Brazos and Colorado Rivers. A unique source of salt is that of the salt cedar tree, which drops a sodium chloride solution from its leaves.

2. Effects of agricultural use on water quality

Waste waters from agriculture are primarily return flows from irrigated lands. Improper cultivation may result in extensive erosion with a resultant high sediment load. Dissolved solids in the applied irrigation waters are concentrated as water is "consumed" by evaporation and transpiration. Additional dissolved solids are leached from the soil, and a load of organic and inorganic chemicals may be anticipated from applied fertilizers, insecticides, and herbicides.

The effects of these pollutants on stream water quality may cause problems in salinity, hardness, temperature, turbidity, nutrients, and aquatic growths, tastes and odors, nitrates and fluorides, toxicity, and bacteria. Except for temperature and bacteria, most of these quality degrading characteristics are cumulative, and tend to increase in concentrations as the stream is used and re-used by successive irrigations.

3. Effects of municipal use on water quality

The waste water from a municipality is primarily domestic sewage, with additional waste products from connected commercial and industrial establishments and street washings. Although relatively dilute (municipal sewage generally contains more than 99.9 per cent water), the organic constituents are potentially noxious and infectious. For each 1,000 persons served, or industrial population equivalent, the following increment (lbs.) may be expected in the waste water:

Table I-1

Average Composition of Domestic Sewage IV-1/
(Pounds per 1,000 persons)

	Mineral	Organic	Total	5-day BOD 20C
1. Suspended Solids	55	143	198	93
a. Settleable	33	86	119	42
b. Nonsettleable	22	57	79	51
2. Dissolved Solids	176	176	352	27
3. Total Solids	231	319	550	120

Each person may be expected to add 125 to 150 billion coliform bacteria per day in winter, and almost 400 billion per day during the summer months. The coliform bacteria are an indicator group that are readily identified as originating in the intestinal tract of warm-blooded animals. Actual total bacteria counts may exceed 1,000 times the coliform count. The number of disease-causing bacteria depends on the number of cases and carriers of disease in the community.

4. Effects of industrial use on water quality

Industrial wastes vary so widely in quality that no broad generalization can be made. Table I-2 contains a list of industrial groups IV-2/ indicating the major constituents in used water.

Improvement of Water Quality at the Source of Degradation

Naturally Polluted Waters

Watershed management is the most effective method of improving the quality of naturally polluted streams.

Watershed management improves the quality of runoff by lessening the sediment and mineral load. Improvement of water quality by removing silt has a beneficial effect on flood control since this silt would fill the reservoirs and river channels, displacing the space allocated for flood waters; it also reduces the treatment costs of subsequent municipal and industrial users. Watershed management permits a better distribution of rainfall to upstream ground water through retention, seepage, and percolation.

A river basin, though technically a single watershed, is actually a mosaic of many tributary watersheds, each with its own characteristics. These watersheds may be considered as having two quality-related components: the plant cover at and above the surface, and the soil and rock mantle at and below the surface.

Although the primary purpose of watershed management is to conserve the soil, the reservoir function of the plant cover and soil and rock mantle can be managed to obtain optimum quality and quantities of runoff and ground water. Initial storage of rainwater is on the leaves and branches of vegetation, on the soil surface, in the soil mantle, in the cracks and fissures of bedrock, in underground reservoirs, and in the valley fill.

Release of watershed waters is effected by evaporation and transpiration, direct release through overland flow, gravity move-

Table I-2

Characteristics of Certain Industrial Wastes

		Waste Characteristics [IV-3/]						
		Inorganic Solids		Organic Solids		Grease	Toxic	Corrosive
Group	Industry	Susp.	Diss.	Susp.	Diss.			
I.	Mining	X	X					
II.	Primary Metals		X				X	X
III.	Transportation Equipment			X		X	X	
IV.	Stone, Clay, & Glass	X						
V.	Food	X		X	X	X		
VI.	Textile		X	X	X	X		
VII.	Paper			X	X			
VIII.	Chemicals	X	X		X		X	X
IX.	Petroleum		X		X	X	X	X

ment through the ground with emergence as springs, in stream channels, and to ground water storage.

Plants add organic matter to the land surface and thus deepen the soil. Their roots also deepen the soil by prying into the subsoil and disintegrating the underlying rock. Three inches of this good topsoil is capable of retaining half an inch of water. IV-4/ This waterbearing topsoil is held in place by the plant robe -- destruction of the plant robe by fire or improper agricultural use may result in the erosion of the topsoil with subsequent damage to the quality and flow control in the receiving stream.

Velocity control above an impoundment reduces scour and excessive silt during periods of high runoff and thus decreases the rate of silting in the impoundment. Growth of phreatophyte trees in the flood plain has been observed to effect this quality improvement of inflow Pecos River water to Lake McMillan.

Proir to 1912, the valley of the Pecos River above Lake McMillan was largely low-growing saltgrass. A few seedlings of salt cedar, as observed in 1912, grew to 3 - 5 feet high and covered an area of 600 acres by 1915. By 1939, they expanded to an area of 9,800 acres. The desilting of floodwater entering McMillan Reservoir is described by Robinson IV-5/:

> "The average rate of silting in the 21.42 years of record before 1915 was 1,933 acre-feet per year, as contrasted with 294 acre-feet per year in the 17-year period after 1915. The increasing effectiveness of the salt cedar in desilting the floodwater is shown by a decrease in the average yearly rate of silting from 350 acre-feet in the 10-year period 1915-1925 to 215 acre-feet in the 7-year period 1925-1932."

The use of phreatophytes in velocity control is costly in terms of transpiration loss of water:

> "The average stream flow depletion by salt cedar above Lake McMillan in the 6-year period May 1934 to July 1940 has been computed as 54,300 acre-feet per year. This is nearly three times the average annual rate of evaporation (19,100 acre-feet) from Lake Avalon. The use of salt cedar, then, evolves into a question of economics, that of balancing the additional effective life of the reservoir against the annual water use by the plants. A further consideration is the question of whether the higher flood levels caused by the phreatophyte growth and the sedimentation can be tolerated."

Downstream from McMillan Dam the quality degradation caused by phreatophytes is substantial. An inflow of highly saline ground water enters the Pecos River about 20 miles upstream from the Texas state line. The inflow adds about 420 tons of dissolved minerals daily. Transpiration loss of water from the salt cedar reduces the dilution of the salt water inflow, resulting in even saltier water. This salt concentration renders the river unfit for irrigation during period of low flow.

Tributaries that flow over natural salt beds reflect this contact in the high dissolved solids content. The concentration of salt varies with the discharge, and is especially high when freshets flush accumulated salt from the tributary banks. Several methods of keeping these dissolved solids out of the main stem may be considered:

> Total impoundment: If the total annual discharge (less evaporation and seepage) can be impounded feasibly, then the main stem will be protected from the excessive dissolved solids in the tributary waters. However, the quantity of water is also sacrificed with this technique. Other complications may occur in the form of an excessive accumulated concentration of salt in the impounded waters that may contaminate adjacent fresh water aquifers. Specially constructed spillways may be constructed to permit high flows of fresh waters to skim over the heavier stratified salt water.
>
> Off-site impoundment: The salt-laden waters of a naturally contaminated tributary may be pumped out of the channel to an off-site reservoir or evaporation bed. This would have an advantage over total impoundment in that less storage would be required, and diluted high flows would be permitted to reach the main stem of the receiving river.
>
> Injection: Concentrated brine may be injected to deep brine strata or for repressuring oil fields, as in the injection of oil field brines. Pre-injection treatment is usually required to prevent clogging.

The Public Health Service is currently conducting an extensive field research on possible methods of keeping natural salt out of the Arkansas and Red Rivers.

The most readily apparent "natural pollution" is sediment transport by water. Once in the stream channel, suspended sediment may either settle out or increase in concentration, depending on whether the velocity is slow or fast.

Improving water quality by decreasing the suspended sediment concentration may be accomplished by watershed control, impoundment, or velocity control (settling basins).

Quality control at the mouths of rivers may be effected by the use of salt water barriers. The fresh river water, being lighter than salt water, permits the subsurface intrusion of the heavier salt water for some distance upstream. Construction of physical barriers to prevent this intrusion can make a greater proportion of the stream flow available to downstream users above the barrier, especially at low flows. It has been estimated by S. W. Freese (Minutes of Conference on M & I Water Requirements - Beaumont - May 10, 1960) that 1500 cfs of Neches River flow is required to control salt water encroachment and protect the Neches Valley Authority intake. It was suggested that the water be conserved by the installation of a salt water barrier.

Agricultural Waste Waters

Waste waters from agriculture are primarily return flows from irrigated lands. Quality degradation of waters used for irrigation include concentration of salts that are left behind when evaporation and transpiration occur, increased concentration of salts that are leached from the soil, and organic and inorganic chemicals that have been applied as fertilizer, insecticides, and herbicides.

No direct treatment of these return waters is feasible to improve their quality. The increased concentration of dissolved mineral salts can only be removed by desalinization, a process that, due to its cost, is limited to treating water for direct industrial or municipal use, not for waste water treatment. Raymond A. Hill IV-6/ has described the effects of irrigation return flows on the receiving stream:

> "This progressive depreciation of the quality of water is quite natural where the stream flow is used and re-used for irrigation. When water is applied to land, a large part of it is transpired by plants and evaporated from moist soil. Very little of the salt in the water is taken up by the plants; consequently, there is a much greater concentration of salts in the soil solution than in the irrigation supply. Since the carbonates of calcium and magnesium are sparingly soluble, they are precipitated first. The irrigation percolate, which finds its way back into the river either through drains or by natural seepage, thus contains a higher proportion of sulfates, chlorides, and sodium than the waters that were diverted for irrigation. Progressively downstream, water is lost to the atmosphere by evaporation and the less soluble salts are left behind by precipitation, until only irrigation sewage remains."

The improvement of water quality of a stream in this condition can only be accomplished by dilution with a sufficient amount of water containing low dissolved solids.

The significance of agricultural insecticides is becoming an increasingly important factor in the protection of public water supplies. Organic insecticides applied on cotton fields in Alabama were washed into streams by rainfall in quantities sufficient to produce striking fish kills. In such areas, investigations are needed to determine whether or not the finished municipal water supply carries toxic materials.

One of the requirements for the production of algae is the availability of nutrient materials such as calcium, nitrates, phosphates, iron, potassium, sulfur, magnesium, and carbon dioxide. With the exception of nitrates and phosphates, the nutrient materials are usually present in waters in quantities in excess of requirements. Therefore, the addition of soluble nitrates and phosphates to waters deficient in these nutrients usually results in an increased production of algae. Sawyer established the threshold values of 0.30 ppm of inorganic nitrogen and 0.015 ppm of inorganic phosphorus above which heavy production of algae, frequently referred to as algal blooms, may occur.

Extensive studies in Wisconsin of the odor nuisance occurring in the Madison Lake showed that the heavy production of plankton in the lakes resulted from the addition of fertilizers, particularly phosphates and nitrates, contributed by (1) domestic sewage, (2) agricultural drainage, (3) stock raising, and (4) trade wastes.

In the report on Lake Mendota (Wisconsin) Studies, it was concluded that a drainage area that is nonurban, such as that of Lake Mendota, can supply by runoff through its drainage system sufficient nutrients to fertilize the water to the nuisance-producing level of algal production. Specific analyses are included in these reports that show that drainage water from agricultural lands contains high amounts of inorganic nitrogen (up to an average of 11.4 ppm) and total phosphorus values in agricultural drainage that are higher than in most streams in the area. It was concluded in these reports that fertilizers added to the land were responsible for high values of nitrates in streams draining these lands.

The effects of withdrawing water for irrigation purposes will be twofold: (1) increase the concentration of nutrient salts (nitrates and phosphates) in the stream through lack of dilution of sewage plants effluent and (2) increase the concentration of nutrient salts (nitrates and phosphates) in the return irrigation water. Also of importance are the contributions of organic phosphorus and nitrogen from irrigated lands which can be converted to soluble inorganic salts in the watercourse.

A method for estimating the salinity in a stream below the point of irrigation return flow has been suggested by L. V. Wilcox, U. S. Salinity Laboratory, Riverside, California. IV-7/

$$K = \frac{(JD) + (GI)}{J + G}$$

where K = Concentration of salts in the stream below the return flow, ppm.

J = Overflow, acre-feet per day.

D = Concentration of salts in the water applied.

G = Return flow, acre-feet per day.

I = Concentration of salts in return flow, ppm.

Fertilizers, insecticides, and herbicides cannot feasibly be removed from irrigation return waters. To improve the quality of these return waters, the chemicals must be used discriminately. The Department of Agriculture is endeavoring to develop biological substitutes for insecticides.

Municipal Waste Waters

Improvement of the quality of water that has been used by a municipality is accomplished by a series of physical and biochemical processes incorporated in municipal sewage treatment plants.

Municipal sewage includes the water-carried wastes of domestic, commercial, and some industrial users. Although the range of waste products is large, the composite of household, hospital, laundry, hotel, and certain industrial process wastes is amenable to conventional treatment: (1) Floating materials are removed by screening; (2) suspended inorganic materials called "grit" are then removed by passing the screened sewage through chambers at a velocity slow enough to permit the heavy grit to settle out, but fast enough to retain the organic matter in suspension; (3) settleable organic matter is subsequently removed by passing the flow through "primary" settling tanks at a velocity slow enough to retain all organic matter that will settle in two hours. Treatment at this point has all been physical, and is termed "primary" treatment.

Secondary treatment begins with biochemical processes such as activated sludge or trickling filters which are based on the contact of primary effluent with a sticky film or floc of biological matter that removes particles of organic matter that are colloidal, or too small to settle alone. Final settling tanks are used to collect this accumulated organic matter, and the effluent from these tanks is then discharged to the receiving stream, clear, colorless, and, if chlorinated, almost bacteria free. Approximate quality improvement effected by a conventional secondary sewage treatment plant: 100 per cent removal of settleable solids; 90 per cent removal of suspended solids and biochemical oxygen demand; over 99.9 per cent reduction of coliform bacteria (with chlorination). Some fluctuations in effluent quality may be expected as human and mechanical idiosyncrasies enter into plant operation.

Dissolved inorganic solids such as chlorides and sulfates are relatively unaffected by conventional sewage treatment processes. Connell and Berg IV-8/ estimate that the inorganic dissolved solids are increased by 200 to 300 parts per million due to municipal use of water. They cite records of San Antonio, Texas, as an example of this increase:

Table I-3*

Unused and Used Water Supplies

San Antonio, Texas (1957)**
Chemical Analyses of Representative
Samples at Dry Weather Flow
(Results in Parts Per Million, ppm)

	City Water	Raw Sewage	Sewage Plant Effluent	Net Increase
Total Solids	265	750	540	275
Suspended Solids	< 1	260	17	17
Hardness as $CaCO_3$	220	---	230	10
Alkalinity as $CaCO_3$	220	---	240	20
Sulfate as Na_2SO_4	19	---	70	51
Chloride as NaCl	20	---	173	153
Ammonia Nitrogen	0	18	6	6
Nitrite Nitrogen	0	0	2	2
Nitrate Nitrogen	0	0	1	1
Silica as SiO_2	11	---	20	9
Phosphate as PO_4	< 1	23	12	12
Biochemical Oxygen Demand	< 1	270	20	20

*From Connell & Berg IV-8/

**Data supplied by W. N. Wells, Superintendent of Sewage Treatment, San Antonio, Texas

Industrial Waste Waters

Improvement of the quality of water after use by the many types of industry cannot be accomplished by any single conventional process. Food and kindred industries and about 90 per cent of the organic compounds from other industries are amenable to treatment by modifications of the conventional biological treatment process used by municipalities; however, this is not the case for many of the chemical and mineral substances being produced by industry. In the latter category are lignins, lost pulp, chemicals and color from the pulp and paper industry; acids, toxic chemicals, iron salts and heat from the iron and steel industry; heat and alkalies from the aluminum industry; a steadily increasing number of chemical components from the chemical industry; brines, lost oil, sludges, chemicals and heat from petroleum refining; and heat from steam power generating plants.

Heat may be removed from cooling water by recirculating through spray ponds, cooling towers, or by heat-exchange units. Re-use of this water is usually more costly than the "once-through" process and is practiced only where water supplies are limited.

Improvement of the quality of industrial waste waters increases the overhead cost of production. However, when the waste products removed from the plant effluent can be processed for sale as a by-product, the cost may be reduced substantially, and in some cases, even turned to profit. Examples of industries that have used their treatment plants for by-product recovery are: (1) paper making and board mill - paper fibre; (2) anodizing - chemical acid; (3) cuprammonium rayon - copper; (4) straw processing - caustic soda; (5) copper pickling - copper and sulfuric acid; (6) wool scouring - grease; (7) coal washing - coal slurry; (8) distillery and foods - methane.

Klein IV-9/ has stated that, "As a general rule, it is cheaper to deal with industrial wastes at a well-supervised sewage works, and better results are obtained than by means of separate trade waste treatment plants." A unique treatment plant wherein municipal sewage is treated at an industrial waste treatment plant has been installed at Luke, Maryland. The purpose of this arrangement is to add sewage organic nutrients to the wastes from a pulp and paper plant to obtain a balanced nutrient for biological stabilization (activated sludge). Ninety-five per cent of the flow is from the pulp mill and 5 per cent is from three municipalities. IV-10/

Quality control and water conservation may be accomplished by strategic re-use of municipal and industrial waste waters. Heat removal by recirculation of cooling waters has already been mentioned.

Re-use of Municipal and Industrial Waste Water

With the exception of "juvenile" water (of volcanic origin) and "connate" water (trapped in sedimentary rock at the time of formation), all water in the hydrologic cycle is re-used water. Waste waters that are discharged to a stream continue towards the sea until they are intercepted by subsequent downstream users; if these same waters were treated and utilized directly by appropriate industries or agriculture, the quantity and quality of downstream waters would be increased and improved proportionately. According to Gloyna,IV-11/ by the year 1975, 274 million gallons of domestic waste waters will be produced daily in Texas by three-fourths of the state's population concentrated in the eastern third of the state. Treated sewage is now being used for boiler water in at least three places in Texas: Big Springs, Amarillo, and Odessa. In these plants, conventional techniques for reducing hardness, phosphates, silica, and total solids are used, with slight modifications.

In irrigation, treated sewage effluent can be safely used to grow grains, cotton, hay, fruit trees, and grass. At Lubbock, Texas, 2,100 acres are being farmed with secondary treated sewage, and at San Antonio, 20 to 30 million gallons a day of sewage effluent are used to irrigate cotton, hay, and grass. Similar use of treated effluents is made at Abilene, Andrews, Brownsville, Kingsville, Midland, and San Angelo. Austin, Texas, dilutes activated sludge with river water, converts it to algae by waste stabilization, and uses the high-nitrogen product to irrigate pastureland.

Since over 50 per cent of industrial water use is for cooling waters, at least this amount is available for in-plant use. Strategic use and re-use of water from high-quality process requirements to progressively lower quality requirements processes within a single plant can conserve tremendous quantitites of water. The Fontana steel plant in California is a classic example of such in-plant water economy; its water intake per ton of steel produced is only 1,100 gallons, in contrast with the industry-wide average of 65,000 gallons per ton. IV-12/

Improvement of Water Quality in the Stream

Improvement of water quality in a stream is usually referred to as "self-purification." When the quality has been degraded by decomposable organic materials, the improvement is best described in terms of the dissolved oxygen-related factors. Stable materials, such as minerals and certain fixed organic substances can only be reduced in concentration by dilution. For optimum utilization of a stream for multiple-purpose use, self-purification should be depended upon only after all economically feasible treatment has been applied to waste waters entering that stream.

Pure headwater streams, running in shallow beds and exposed to air, are generally saturated with oxygen. When organic impurities are discharged to the stream, their decomposition by oxygen-demanding bacteria reduces the dissolved oxygen content. The resulting decrease in oxygen content may go to depletion with resulting septic conditions if the counter-force, reaeration, doesn't exceed the demand. The combination of the forces of deaeration and reaeration results in a dissolved oxygen sag that has a critical (minimum) point downstream from the source of organic impurity. The extent and distance from the source depends on the assimilation properties of the particular stream. Man's only direct control over this characteristic of a stream is to limit the impurities that are discharged to the stream, and to control discharges by use of impoundments.

When a dam is placed across a free-flowing stream, the resulting impoundment will effect definite changes in the physical, mineral, bacteriological and sanitary quality of the water. The change in regimen will result in a general improvement of quality, with certain exceptions. The following is a brief summary of the benefits and exceptions for a large impoundment.

Impoundment causes water to have lower summer temperatures than the overlying atmosphere. This is due to the high specific heat of water, which means that much heat is required to warm it; water is also a poor conductor of heat and permits the passage of radiant heat to a limited degree. The resulting lower temperatures are beneficial to practically all downstream waters, especially the municipal and industrial users where large amounts of cooling water are needed. "An outstanding example of this is the Mahoning River, which serves the Youngstown steel district in northeastern Ohio. Natural minimum flows were only about one-twentieth of the cooling water demands, and water temperatures rose to about 120° F. due to the repeated re-use of the stream water.... High water temperature also increases the difficulty and cost of organic pollution abatement by reducing the solubility of oxygen and increasing the rate of decomposition of organic matter.... Flow regulation has aided greatly in overcoming the stream water temperature problem in the Mahoning Valley." IV-13/

Silt and turbidity are removed by quiescence in an impoundment, and the water released from the dam may be expected to be clear, if drawn from a level well above the muddy bottom. However, the released water has more energy and picks up sediment immediately downstream from the dam. During the first six months of discharge from Hoover Dam, the Colorado River lowered its bed two to six feet through the first thirteen miles below the dam. Similar scour occurred below Parker Dam (for 100 miles), resulting in the complete siltation of Imperial Dam twelve years after it had been constructed. IV-14/

Color is reduced by the bleaching action of sunlight, coagulation and sedimentation, and biological action. Approximately 50 per cent of the color in waters entering Fontana Dam was removed over and above the dilution affect. IV-15/

The primary sanitary benefit of water storage is the fact that, in general, disease-producing bacteria are thereby reduced. Lack of proper food, the effects of sedimentation, the disinfecting action of sunlight, devitalization and the depredation of other organisms are all involved in effecting the beneficial reduction. IV-16/

A reduction in the biochemical oxygen demand is accomplished in impoundments by dilution and natural stabilization.

A reduction in dissolved oxygen is a natural consequence of the forces causing a reduction in BOD. Not only the BOD of the influent to the impoundment, but the oxygen demand of bottom sediments, and lack of reaeration often result in a complete depletion of dissolved oxygen in the lower levels of the reservoir. The upper levels of water have a dissolved oxygen content often approaching saturation, due to surface aeration, and high-level outlet structures may be expected to discharge waters with favorable concentrations of dissolved oxygen. Churchill IV-15/ has noted that, although low-level discharges have a dissolved oxygen concentration far below saturation, the BOD of the water is also low, and the rate of reaeration below a dam is relatively rapid. Low rates of released flow are thus reaerated in short distances downstream from the dam, whereas higher discharges require many miles of open-channel flow before oxygen saturation is reached.

Deep, thermally stratified impoundments located downstream from significant deposits of iron ore or manganese ore may release, through deep outlets, water having relatively high concentrations of these minerals in soluble, unoxidized forms.

The equalizing effects of a reservoir on water quality are quite beneficial to downstream municipal and industrial water supplies because the range of variation and the rate of change in almost all water characteristics is significantly reduced, thus facilitating water treatment.

Multiple, selective level outlets may be used to manage salinity. Brine, being heavier than fresh water, tends to accumulate in the lower levels of an impoundment when waters are released from upper levels. By releasing this concentrated brine through low-level outlets during flood periods, a positive control over salinity may be effected.

Improvement of Water Quality Prior to Use

Municipal water treatment plants have the responsibility of furnishing domestic, commercial, and general industrial consumers with water that is clear, pleasant to the taste, of reasonable temperature, neither corrosive nor scale-forming, free from minerals which would produce undesirable physiological effects, and free from organisms capable of producing intestinal infections.

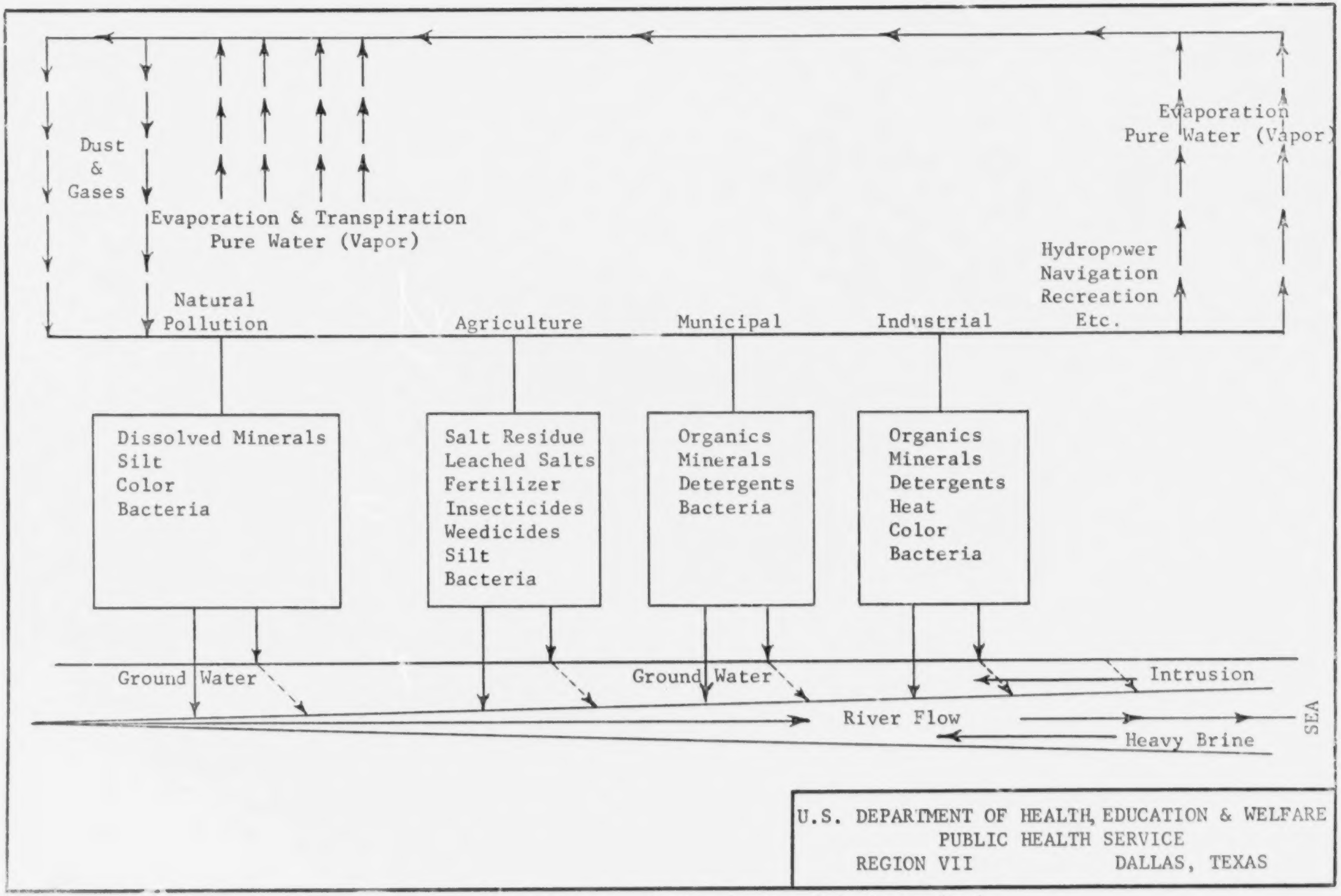
Excluding special treatment processes, water purification may be accomplished by various combinations of seven general methods: prolonged storage; filtration through slow sand filters; chemical coagulation, settling, and filtration through rapid sand filters; softening; iron and manganese removal; and disinfection.

The above conventional methods of improving water quality do not substantially reduce radioactivity, detergents, insecticides, weed killers, fertilizers, and some viruses where these are present in the raw water supplies. To keep these pollutants out of municipal water supplies, they must be prevented from entering the raw water sources.

Industrial water quality requirements vary over a wide range, depending on which of the seven basic uses are to be made of it. The seven basic categories include steam generation, heat transfer, solvent action, carrier, raw material, kinetic energy, and nuclear energy.

The basic conventional water treatment methods used for municipal water supplies are applicable to most industrial needs. This treatment is sufficient for the sanitary systems and many of the industrial processes. Water for cooling purposes normally needs very little quality adjustment, whereas water for certain processes, especially high pressure boiler feedwater and pharmaceutical chemical processes, may have ultra-pure quality requirements. The ultimate in water purification processes is distillation.

317.A


Dust
&
Gases
Evaporation & Transpiration
Pure Water (Vapor)
Evaporation
Pure Water (Vapor)
Hydropower
Navigation
Recreation
Etc.
Natural
Pollution
Agriculture
Municipal
Industrial
Dissolved Minerals
Silt
Color
Bacteria
Salt Residue
Leached Salts
Fertilizer
Insecticides
Weedicides
Silt
Bacteria
Organics
Minerals
Detergents
Bacteria
Organics
Minerals
Detergents
Heat
Color
Bacteria
Ground Water
Ground Water
Intrusion
River Flow
Heavy Brine
SEA
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REGION VII
DALLAS, TEXAS

Figure I-1. Quality Degradation in the Hydrologic Cycle

318-18

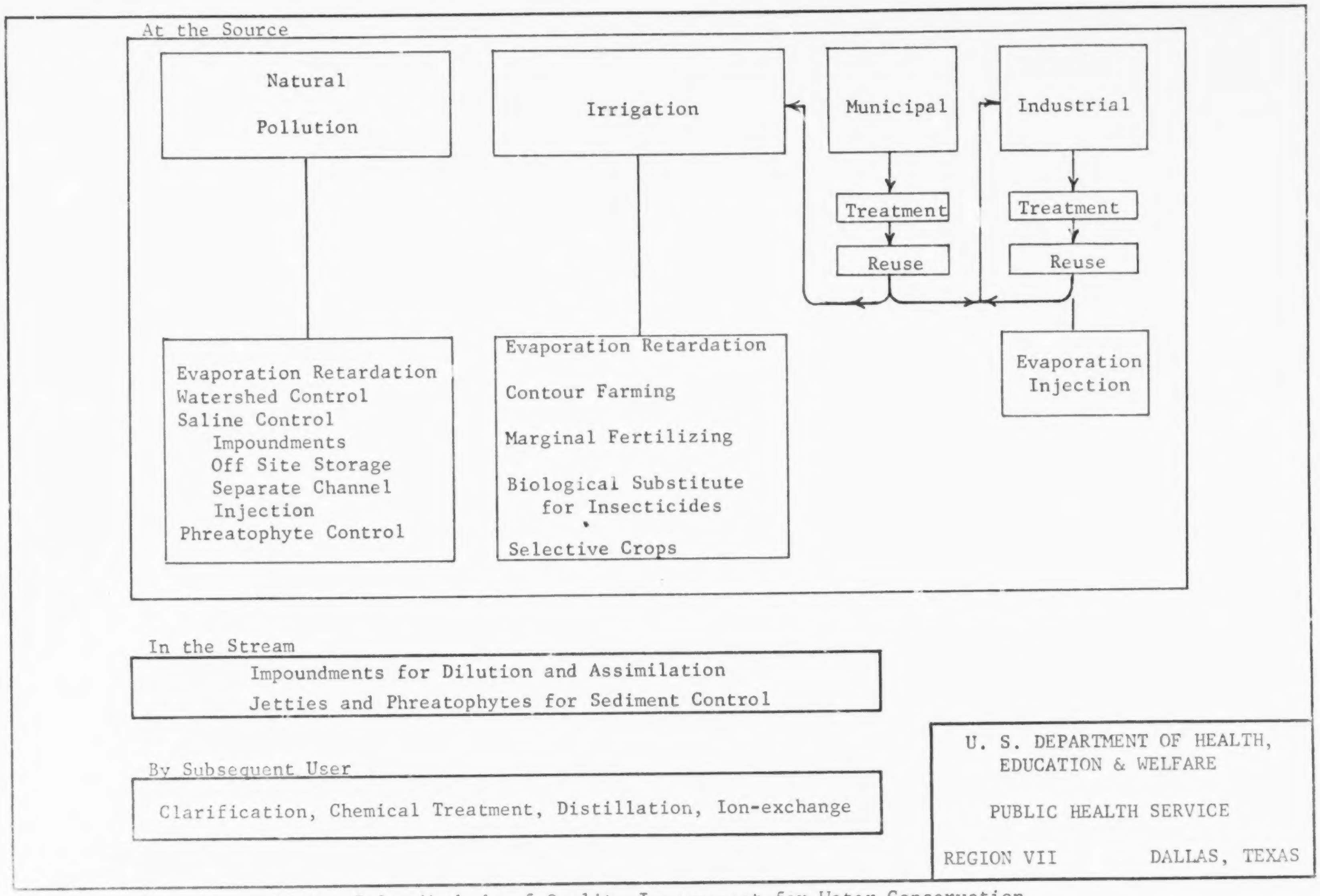
At the Source
Natural Pollution
Evaporation Retardation
Watershed Control
Saline Control
Impoundments
Off Site Storage
Separate Channel
Injection
Phreatophyte Control
Irrigation
Evaporation Retardation
Contour Farming
Marginal Fertilizing
Biological Substitute for Insecticides
Selective Crops
Municipal
Treatment
Reuse
Industrial
Treatment
Reuse
Evaporation Injection
In the Stream
Impoundments for Dilution and Assimilation
Jetties and Phreatophytes for Sediment Control
By Subsequent User
Clarification, Chemical Treatment, Distillation, Ion-exchange
U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VII
DALLAS, TEXAS

Figure I-2. Methods of Quality Improvement for Water Conservation

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    4. No. 6001. Surface Runoff from Texas Watersheds and Subbasins.
- B. U. S. Geological Survey Water Supply Papers
    1. Surface Water Supply of the United States - Part 8. Western Gulf of Mexico Basins.

	Year	WSP No.
a.	1958	1562
b.	1957	1512
c.	1956	1442
d.	1955	1392
e.	1954	1342
f.	1953	1282
g.	1952	1242
h.	1951	1212
i.	1950	1178

j.	1949	1148
k.	1948	1118
l.	1947	1088
m.	1946	1058
n.	1945	1038

(For previous discharge records, see Reference IA-1, TBWE 5807-A)

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	Year	WSP No.
a.	1958	1573
b.	1957	1522
c.	1956	1452
d.	1955	1402
e.	1954	1352
f.	1953	1292

g.	1952	1252
h.	1951	1199
i.	1950	1188
j.	1949	1163
k.	1948	1133
l.	1947	1102
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n.	1945	1030

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